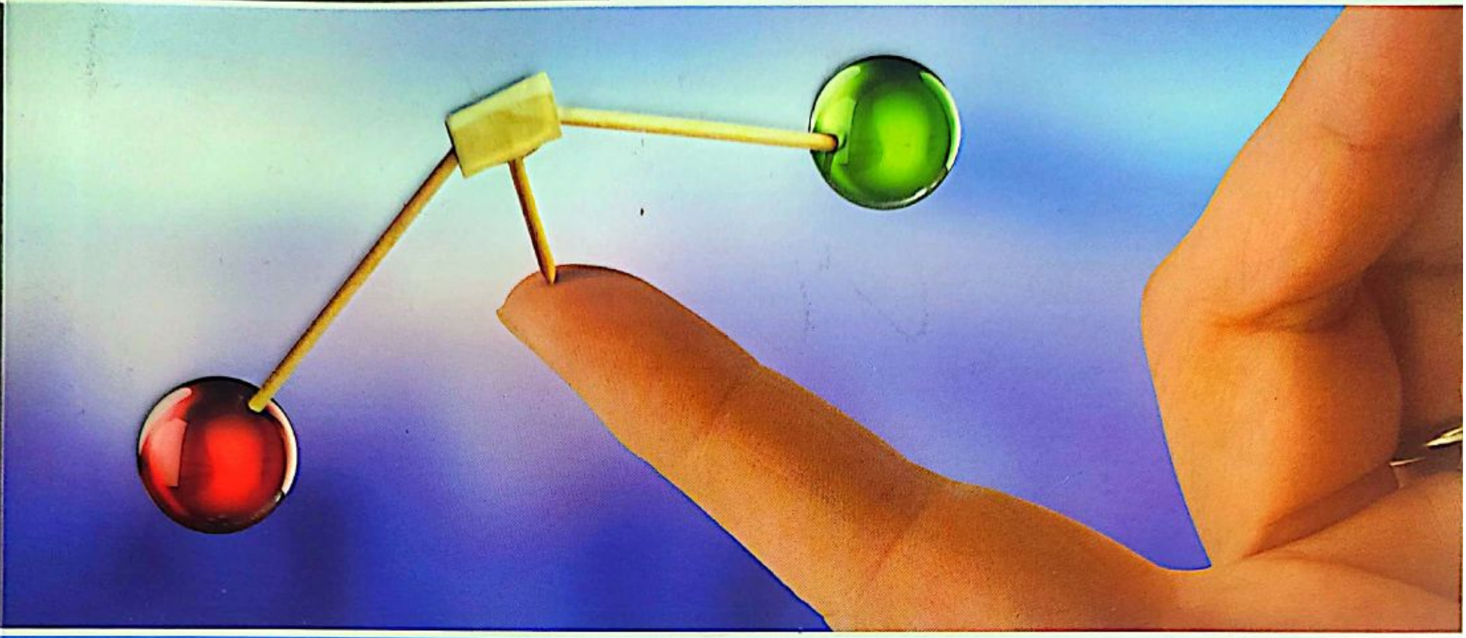
Applied Mathematics Statics



Question Bank
& Practice Exams

EL-MOASSER

By a group of supervisors

3rd Sec

2022

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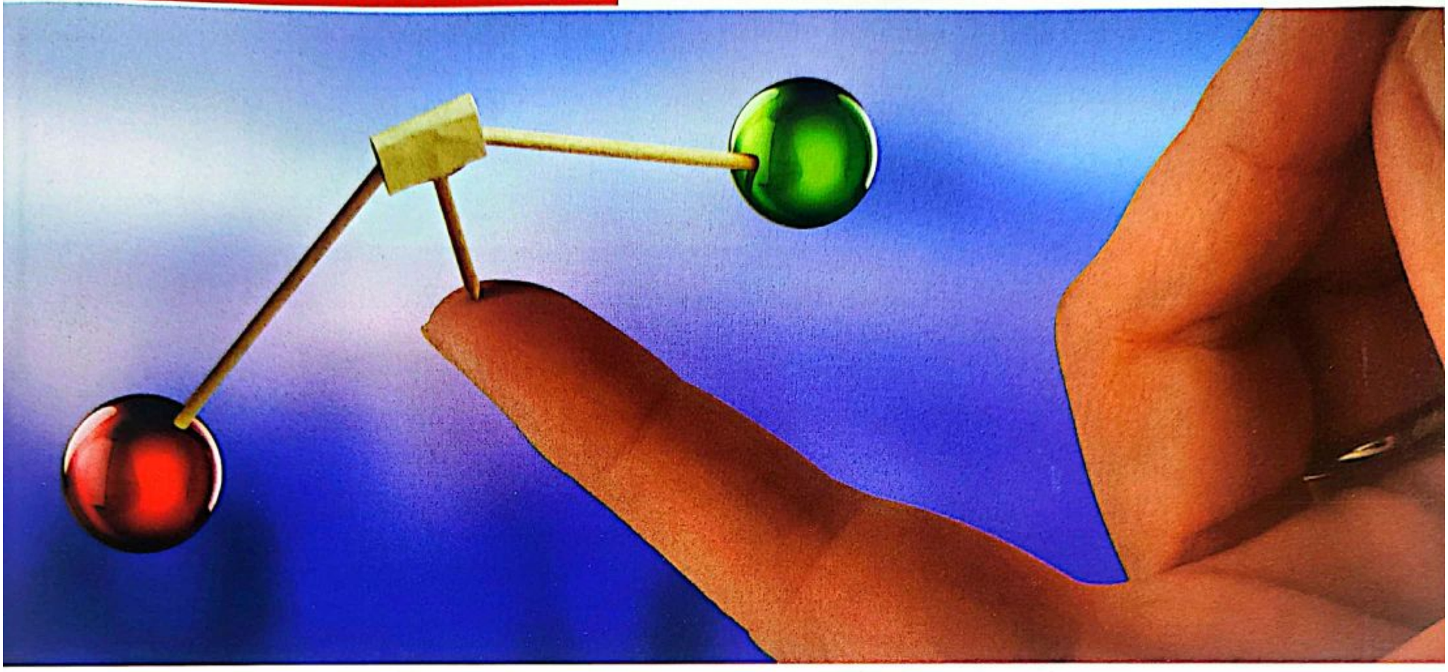
APPLIED MATHEMATICS Statics



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Preface

Thanks to God who helped us to introduce one of our famous series "El Moasser" in mathematics.

We introduce this book to our colleagues.

We also introduce it to our students to help them study mathematics.

In fact, this book is the outcome of more than thirty years experience in the field of teaching mathematics.

This book will make students aware of all types of questions.

We would like to know your opinions about the book hoping that it will win your admiration.

We will be grateful if you send us your recommendations and your comments.

The Authors

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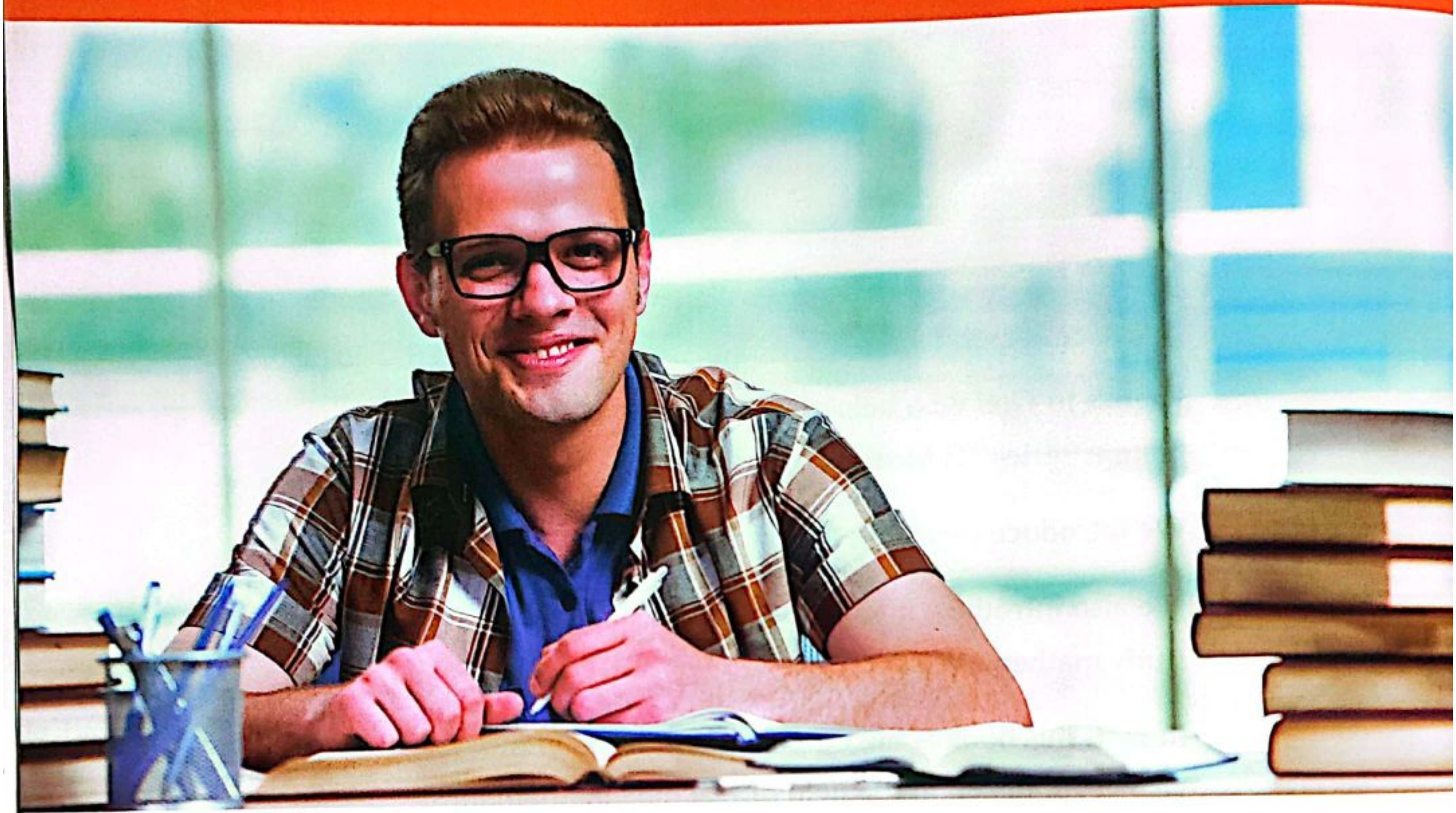
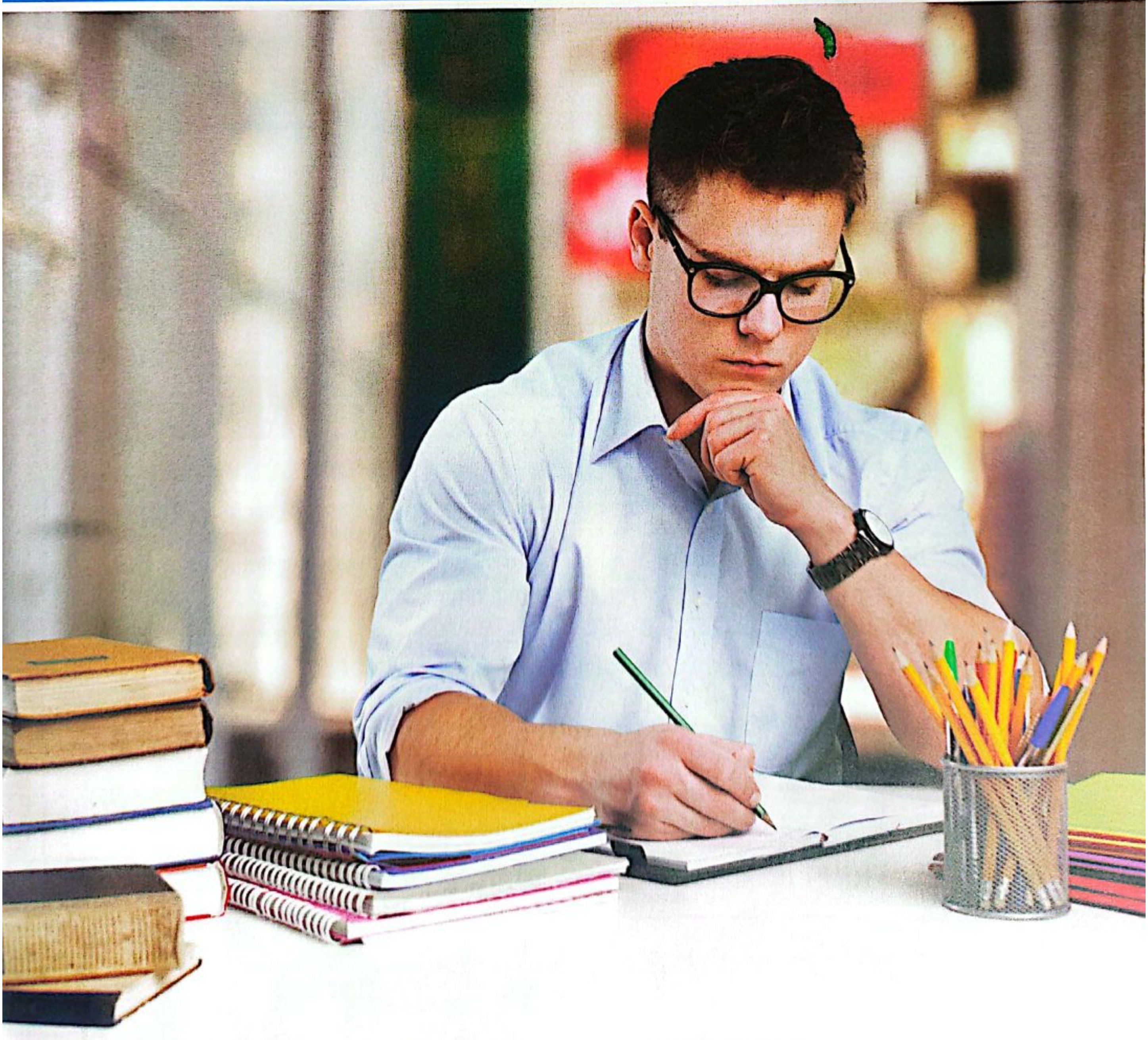


Summary

for

Statics



Friction

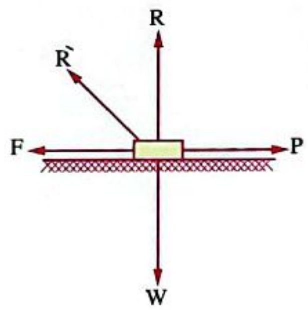
If $\vec{F}$ is the static friction force , $\vec{F}_s$ is the limiting static friction then.

The coefficient of static friction

The ratio between the two magnitudes of the limiting static friction's force (F_s) and the normal reaction ($\vec{R}$) is called the coefficient of friction between the two surfaces in contact and it is denoted by μ_s

i.e. $\boxed{\mu_s = \frac{F_s}{R}}$, then $\boxed{F_s = \mu_s R}$ where $0 \le F \le F_s$ **i.e.** $0 \le F \le \mu_s R$

The resultant reaction



The resultant reaction is denoted by $\grave{\vec{R}}$

It is the resultant of the normal reaction $\vec{R}$

and the force of friction $\vec{F}$

i.e. $\grave{R} = \sqrt{R^2 + F^2}$

In the case of limiting friction we find that $\boxed{\grave{R} = \sqrt{R^2 + F_s^2}}$

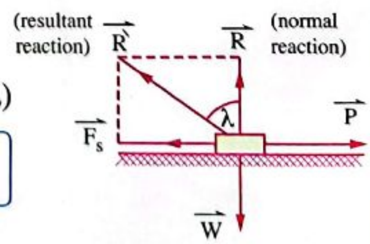
$\because F_s = \mu_s R$ (the limiting friction) $\therefore \grave{R} = \sqrt{R^2 + \mu_s^2 R^2}$

$\therefore \grave{R} = R\sqrt{1 + \mu_s^2}$

The angle of friction

It is the angle included between the resultant reaction and the normal reaction when the magnitude of the friction's force is the limiting value

i.e. When $F_s = \mu_s R$



The measure of angle of friction is denoted by the symbol (λ)

, then $\boxed{\tan\lambda = \frac{F_s}{R} \text{ but } \frac{F_s}{R} = \mu_s}$ $\therefore$ $\boxed{\mu_s = \tan\lambda}$

i.e. The tangent of the angle of friction equals the coefficient of static friction.

, $\because$ $\boxed{\grave{R} = R\sqrt{1 + \mu_s^2}}$ $\therefore$ $\boxed{\grave{R} = R\sqrt{1 + \tan^2\lambda} = R\sqrt{\sec^2\lambda} = R\sec\lambda}$

Kinetic friction force (F_k)

$F_k = \mu_k R$ "Where μ_k is the kinetic friction coefficient".

The Kinetic friction coefficient (μ_k)

- The coefficient of kinetic friction can be defined as the ratio between the kinetic friction force and the normal reaction.
- Coefficient of frictions μ_s , μ_k depending on the nature of the two bodies not on their shapes or masses or area of the surfaces in contact.
- The coefficient of kinetic friction μ_k < the coefficient of static friction μ_s

The equilibrium of a body on a horizontal rough plane

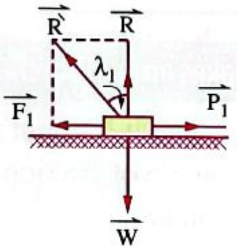
1. If the force is horizontal

The body is at rest.

- The equations of equilibrium

$R = W \text{ , } F = P$

- $0 \le F_1 < \mu_s R$
- $\grave{R} = \sqrt{P^2 + R^2}$
- $\lambda_1 < \lambda$



The body is about to move

- The equations of equilibrium

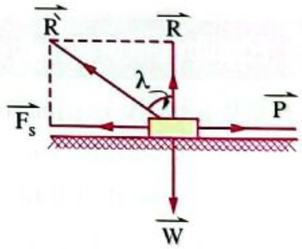
$R = W \text{ , } P = F_s = \mu_s R$

- $\grave{R} = \sqrt{F_s^2 + R^2}$

$= \sqrt{\mu_s^2 R^2 + R^2}$

$= R\sqrt{\mu_s^2 + 1}$

- $\lambda_1 = \lambda \text{ , } \mu_s = \tan \lambda$



Notice that

The horizontal force which makes a body of weight (W) placed on a rough plane about to move is $\boxed{P = W \tan \lambda}$ where λ is the angle of friction.

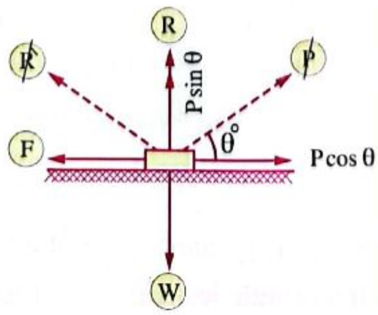
2. If the force is inclined to the horizontal with an angle of measure θ :

The body is at rest :

- The equations of equilibrium

$R + P \sin \theta = W$

$F = P \cos \theta$

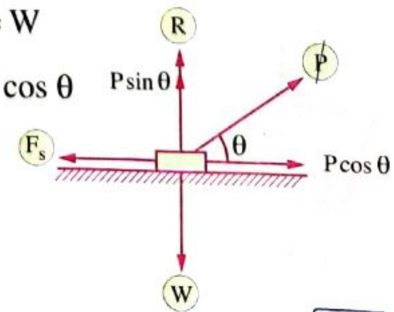


The body is about to move :

- The equations of equilibrium

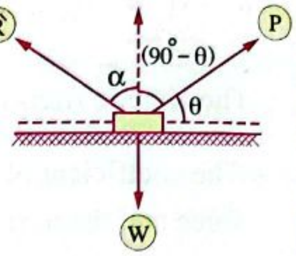
$R + P \sin \theta = W$

$F_s = \mu_s R = P \cos \theta$



Notice that

The body is in equilibrium under the action of three forces , they are : $\vec{P}$, $\vec{W}$, $\vec{R}$



Using Lami's rule :

$$\therefore \frac{P}{\sin(180° - \alpha)} = \frac{\acute{R}}{\sin(90° + \theta)} = \frac{W}{\sin\left(90° - (\theta - \alpha)\right)}$$

$$\therefore \boxed{\frac{P}{\sin \alpha} = \frac{\acute{R}}{\cos \theta} = \frac{W}{\cos(\theta - \alpha)}}$$

In case the body about to move , then $\alpha = \lambda$ and the previous relation becomes

$$\frac{P}{\sin \lambda} = \frac{\acute{R}}{\cos \theta} = \frac{W}{\cos(\theta - \lambda)} \qquad \therefore P = \frac{W \sin \lambda}{\cos(\theta - \lambda)}$$

$\therefore$ For every angle of inclination θ between the force and the horizontal , there is a different magnitude of the force P which makes the body about to move and the least magnitude of P occurs when $\cos(\theta - \lambda)$ is maximum **i.e.** $\theta = \lambda$

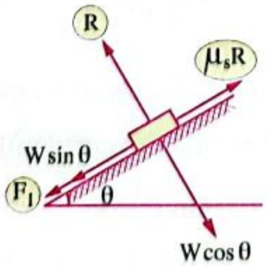
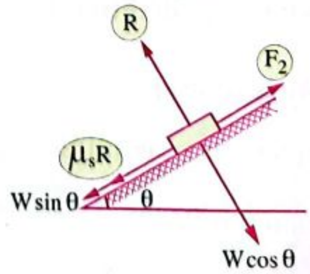
From previous we deduce that :

The least force can make a body of weight (W) placed on a rough horizontal plane , about to move is $\boxed{P = W \sin \lambda}$ and above the horizontal at an angle of measure as measure of (λ)

Equilibrium of a body on a rough inclined plane makes an angle of measure (θ) above the horizontal

1. If a body is placed on a rough inclined plane and it is about to slide under the action of its weight only , then the measure of the angle of friction equals the measure of the angle of inclination of the plane to the horizontal.

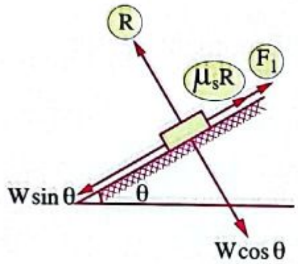
2. If $\theta < \lambda$: then the body stays at rest on the plane (It is in equilibrium and not about to move) The friction can be limiting if force F_1 acts on the body in direction of the line of greatest slope as follow.

⊙ The force $\overrightarrow{F_1}$ makes the body about to move downwards the plane.  ⊙ The two equations of equilibrium are : $R = W \cos \theta$, $\mu_s R = F_1 + W \sin \theta$	⊙ The force $\overrightarrow{F_2}$ makes the body about to move upwards the plane.  ⊙ The two equations of equilibrium are : $R = W \cos \theta$, $F_2 = \mu_s R + W \sin \theta$

⊙ If a force acted on the body in the direction of the greatest slope of the plane downwards with magnitude less than F_1 or upwards with magnitude less than F_2 , then the body be at rest.

3. If $\theta > \lambda$, then the body will not be in equilibrium under the action of its weight only. We can make the body about to move downwards the plane or upwards the plane by acting on it by a force in the direction of the line of greatest slope upwards as follows :

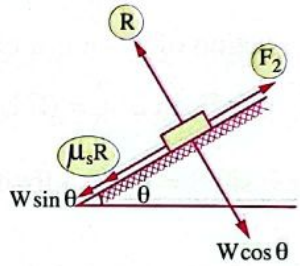
- The force $\overrightarrow{F_1}$ at which the body is about to slide , then it is the least force keeps the equilibrium of the body.



- The two equations of equilibrium are :

$R = W\cos\theta$, $F_1 + \mu_s R = W\sin\theta$

- The force $\overrightarrow{F_2}$ makes the body about to move upwards the plane , then it is the greatest force keeps the equilibrium of the body.



- The two equations of equilibrium are :

$R = W\cos\theta$, $F_2 = \mu_s R + W\sin\theta$

- If a force acted on the body in the direction of the greatest slope of the plane upwards of magnitude greater than F_1 and less than F_2 , then the body be at rest.

i.e. Values of F which make the body in equilibrium $\in [F_1 , F_2]$

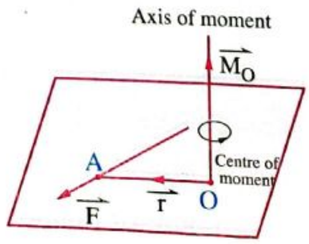
4. To identify the direction of friction, compare between the component of forces acting on the body in direction of the line of greatest slope upward and downward, the direction of friction acts in opposite direction to their greatest.

Moments

The moment of a force with respect to (or about) a point

It is a vector quantity determines to us the ability of the force to make rotation to the body about a point or axis.

This moment depends on two factors :



1. The norm (the magnitude) of the force.

2. The distance between its line of action and the centre (or the axis) of rotation.

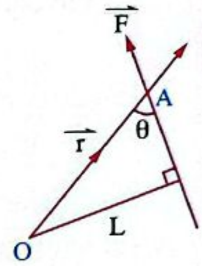
Summary

Moment of a force about a point.

- If $(\vec{r})$ is the position vector of any point (A) on the line of action of force $\vec{F}$ with respect to the point (O)

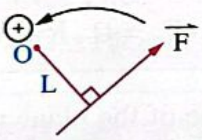
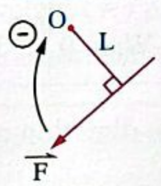
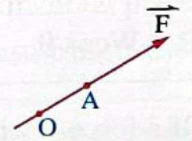
Then : $\boxed{\text{The moment vector of } \vec{F} \text{ about O } (\overrightarrow{M_o}) = \vec{r} \times \vec{F}}$

- If θ is the measure of the smaller angle between $\vec{r}$ and $\vec{F}$ when they are drawn from the same point , L is the perpendicular distance from O to the line of action of $\vec{F}$, $\hat{e}$ is a unit vector in direction of moment vector , then $\overrightarrow{M_o} = (r\,F \sin\theta)\,\hat{e} = (F\,L)\,\hat{e}$



- $\|\overrightarrow{M_o}\| = r\,F\sin\theta = F \times L$, then $L = \dfrac{\|\overrightarrow{M_o}\|}{F}$

The algebraic measure of the moment M_o :

		
$M_o = FL$	$M_o = -FL$	$M_o = \text{zero}$
The direction of rotation of $\vec{F}$ about O is anticlockwise	The direction of rotation of $\vec{F}$ about O is clockwise	The line of action of $\vec{F}$ passes through O

Principle of moments (Varignons theorem)

The moment of a force $\vec{F}$ about a point equals the sum of the moments of the components of the force about the same point.

Theorem of moments

The sum of moments of a number of coplanar forces meeting at one point with respect to any point in the space equals the moment of the resultant of these forces with respect to the same point.

The general theorem of moments

The algebraic sum of the moments of these forces about a certain point is equal to the moment of the resultant about this point.

Remarks

1. The unit of measuring the moment = the unit of the norm of the force × length unit

2. L (The length of the perpendicular drawn from O on the line of action of $\vec{F}$) = $\frac{\|\overrightarrow{M_o}\|}{F}$

3. The moment of a force with respect to a point is constant and is independent on the position of the point chosen on the line of action of the force $\vec{F}$

4. If M_A = zero , then either R = zero or A $\in$ the line of action of $\vec{R}$

5. The moment of a force about any point on its line of action is the zero vector and in general : the algebraic sum of moments of set of forces about any point on the line of action of their resultant equals zero.

6. $\boxed{\text{If } \overrightarrow{M_A} = \overrightarrow{M_B} \text{ , then } \vec{F} \,//\, \overleftrightarrow{AB}}$

and in general , if the sum of moments of set of coplanar forces about A = the sum of moments of these force about point B then their resultant is parallel to $\overleftrightarrow{AB}$

7. $\boxed{\text{If } \overrightarrow{M_A} = -\overrightarrow{M_B} \text{ , then the line of action of } \vec{F} \text{ bisects } \overline{AB}}$

and in general : if the sum of the moments of set of coplanar forces about A = – the sum of moments of these forces about B then the line of action of their resultant bisects $\overline{AB}$

8. If a force $\vec{F}$ acts in a plane and $\overline{AB}$ is subset of this plane and C divides $\overline{AB}$ in ratio m : n Then

$nM_A + mM_B = (n + m)\, M_C$

and if C is the midpoint of $\overline{AB}$ then $M_A + M_B = 2M_C$

9. If force $\vec{F}$ acts in the plane of parallelogram ABCD and M_A , M_B , M_C , M_D are the algebraic measures of force moments about the four vertices of the parallelogram respectively

, then $\boxed{M_A + M_C = M_B + M_D}$

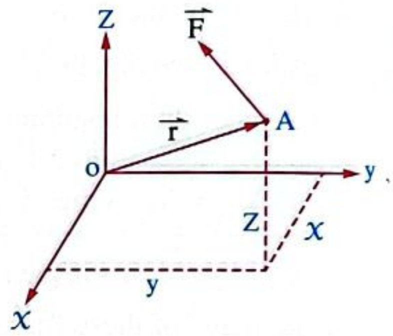
The moment of a force about a point in a 2D-coordinate system :

If the force $\vec{F} = F_x \hat{i} + F_y \hat{j}$ acts at point A whose position vector with respect to origin "O" is $\vec{r} = (x , y)$

Then : $\boxed{\overrightarrow{M_o} = \vec{r} \times \vec{F} = (x , y) \times (F_x , F_y) = (x F_y - y F_x) \hat{k}}$

The moment of a force about a point in a 3D-coordinate system :

If the force $\vec{F} = F_x \hat{i} + F_y \hat{j} + F_z \hat{k}$ acts at a point A whose position vector with respect to origin "O" is $\vec{r} = (x , y , z)$, then :



$$\overrightarrow{M_o} = \vec{r} \times \vec{F} = (x , y , z) \times (F_x , F_y , F_z)$$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ x & y & z \\ F_x & F_y & F_z \end{vmatrix}$$

$$= \underbrace{(y F_z - z F_y)}_{\text{Moment of } \vec{F} \text{ with respect to the } x\text{-axis}} \hat{i} + \underbrace{(z F_x - x F_z)}_{\text{Moment of } \vec{F} \text{ with respect to the } y\text{-axis}} \hat{j} + \underbrace{(x F_y - y F_x)}_{\text{Moment of } \vec{F} \text{ with respect to the } z\text{-axis}} \hat{k}$$

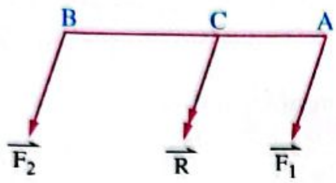
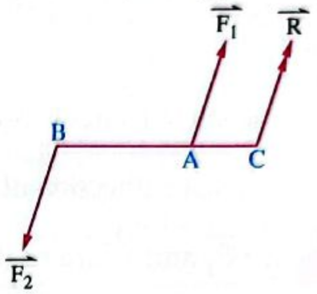
- The length of the perpendicular drawn from (O) to the line of action of force $\vec{F} = \dfrac{\|\overrightarrow{M_o}\|}{\|\vec{F}\|}$
- If the force $\vec{F}$ acts at point A , then the moment of the force $\vec{F}$ about the point B = $\overrightarrow{BA} \times \vec{F}$
- The moment of a force about an axis will vanished in one of the following two cases :

  (1) If the line of action of the forces intersects this axis at a point at least.

  (2) The force is parallel to this axis.

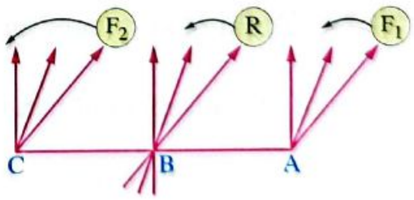
Parallel forces

The resultant of two coplanar parallel forces :

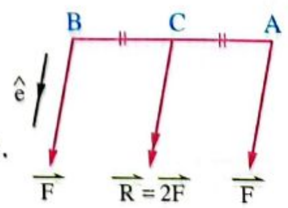
If the two forces have the same direction :	**If the two forces have opposite directions :**
	
Magnitude of resultant $R = F_1 + F_2$	Magnitude of resultant $R = \lvert F_1 - F_2 \rvert$
The direction of $\overrightarrow{R}$ is the same as the two forces.	The direction of $\overrightarrow{R}$ is the same as the greater force.
The point of action of the resultant $\overrightarrow{R}$ divides $\overline{AB}$ internally such that $F_1 \times AC = F_2 \times BC$	The point of action of the resultant divides $\overline{AB}$ externally such that $F_1 \times AC = F_2 \times BC$
From properties of proportion : $\dfrac{F_1}{BC} = \dfrac{F_2}{AC} = \dfrac{R}{AB}$	

Remarks

1. If A and B are two points of action of two parallel forces of magnitudes F_1 , F_2 and magnitude of their resultant is R , then the slope of the two forces changes , the slope of the resultant changes due to that noticing that all line of actions of the resultant in each case intersect at one point lies on $\overleftrightarrow{AB}$ and is called point of action of resultant.



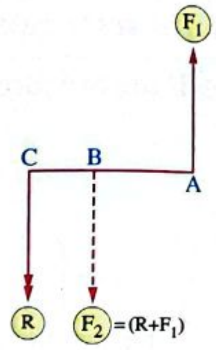
2. If the two forces $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ of the same direction are equal in magnitude , the magnitude of each of them is F act on two distinct points A , B from a rigid body , then :



- The magnitude of the resultant : $R = 2F$
- The direction of the resultant : Is the same direction of the two forces.
- The point of action of the resultant : C is the midpoint of $\overline{AB}$

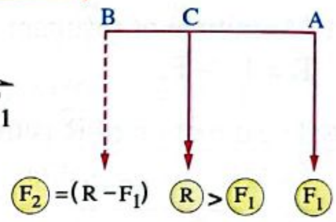
3. If one of the two parallel forces $(\overrightarrow{F_1})$ is known and their resultant $(\overrightarrow{R})$ is known also then, to determine the second force $\overrightarrow{F_2}$ consider the following :

First **If : $\overrightarrow{F_1}$ and $\overrightarrow{R}$ are in opposite directions , then :**



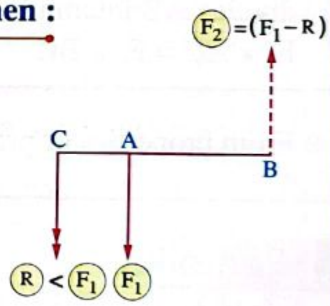
- $F_2 = R + F_1$
- The line of action of $\overrightarrow{F_2}$ lies between the two lines of action of $\overrightarrow{F_1}$ and $\overrightarrow{R}$
- $\overrightarrow{F_2}$ acts in the same direction of $\overrightarrow{R}$

Second **If : $\overrightarrow{F_1}$ and $\overrightarrow{R}$ are in the same direction and $R > F_1$, then :**



- $F_2 = R - F_1$
- The line of action of $\overrightarrow{F_2}$ lies outside the two lines of action of $\overrightarrow{F_1}$ and $\overrightarrow{R}$ in the side of $\overrightarrow{R}$
- $\overrightarrow{F_2}$ in the same direction of $\overrightarrow{R}$

Third **If : $\overrightarrow{F_1}$ and $\overrightarrow{R}$ are in the same direction and $R < F_1$, then :**



- $F_2 = F_1 - R$
- The line of action of $\overrightarrow{F_2}$ lies outside the two lines of action of $\overrightarrow{F_1}$ and $\overrightarrow{R}$ in the side of $\overrightarrow{F_1}$
- $\overrightarrow{F_2}$ in the opposite direction of $\overrightarrow{F_1}$

The resultant of system of parallel coplanar forces :

To identify the resultant of parallel coplanar forces $\overrightarrow{F_1}, \overrightarrow{F_2}, \dots, \overrightarrow{F_n}$, then :

The magnitude and the direction of the resultant $\overrightarrow{R} = \overrightarrow{F_1} + \overrightarrow{F_2} + \dots + \overrightarrow{F_n}$

and the point of action of the resultant can be determined using moment theorem which state that.

> The algebraic sum of the moments of system of parallel forces about a point equals their resultant moment about the same point.

Enrich your knowledge

Let $F_1, F_2, \ldots, F_n$ be the algebraic measures of several parallel forces act at the points : $A_1(x_1, y_1)$, $A_2(x_2, y_2), \ldots, A_n(x_n, y_n)$ respectively, then the algebraic measures of their resultant $= F_1 + F_2 + F_3 + \ldots + F_n$ and the resultant act at point $B(x, y)$, using principle of moment theorem we can get :

$$\boxed{x = \frac{\sum_{i=1}^{n} F_i x_i}{\sum_{i=1}^{n} F_i}} , \boxed{y = \frac{\sum_{i=1}^{n} F_i y_i}{\sum_{i=1}^{n} F_i}}$$

If a rigid body is kept in equilibrium under effect of 3 coplanar forces, then each force equal in magnitude and opposite in direction the resultant of the other two forces and has the same line of action.

Conditions of equilibrium of a system of coplanar parallel forces :

- Conditions of equilibrium of parallel coplanar forces.

1. The sum of the algebraic measures of these forces (with respect to a unit vector parallel to these forces) is equal to zero.
2. The sum of the algebraic measures of the moments of these forces about any point in its plane is equal to zero.

General Equilibrium

- If the sum of a set of coplanar forces vanishes ($\overrightarrow{R} = \overrightarrow{O}$) and the sum of moments of this set of forces vanishes with respect to any point in its plane ($\overrightarrow{M} = \overrightarrow{O}$), it is said that this set of forces are in equilibrium.

- **The converse of this theorem is always true**

i.e. If a set of forces are in equilibrium

Then
- $\overrightarrow{R} = \overrightarrow{O}$ **i.e.** The sum of forces vanishes.
- $\overrightarrow{M} = O$ **i.e.** The moments of these forces vanishes with respect to any point.

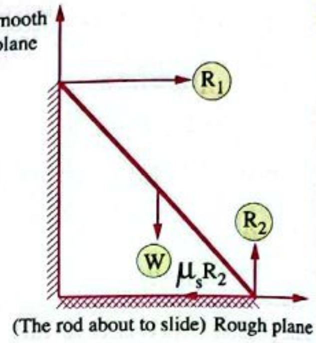
For a set of coplanar forces to be in equilibrium it is necessary and sufficient that :

1. The algebraic sum of the components of the forces in any two orthogonal directions in the plane of the forces must be equal zero. **i.e.** $X = 0, Y = 0$
2. The algebraic sum of the moments of all forces about one point in the plane of forces must be equal zero **i.e.** $M = 0$

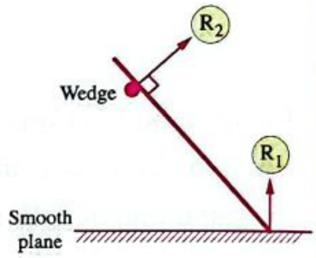
Important remarks to determine the reaction

1. When a rod rests on a smooth plane then the reaction will be perpendicular to the plane.

2. When a rod rests on a rough plane then the reaction becomes in unknown direction and it can be resolved into two components , normal reaction and friction force and if the rod is about to slide then these components will be normal reaction (R_2) and limiting friction ($\mu_s R_2$)



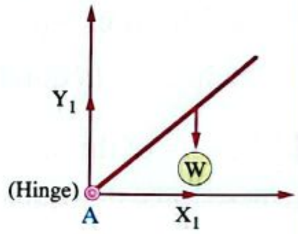
3. When a rod is fixed at one of its internal points on a (wedge - another body) , then the reaction will be perpendicular to the rod.



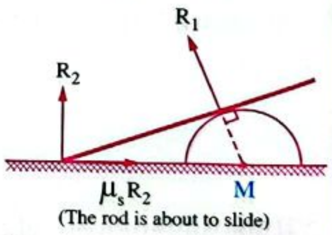
4. The reaction of the hinge acts in an unknown direction and it can be resolved into two components ,

X_1 (in direction of $\overrightarrow{AX}$)

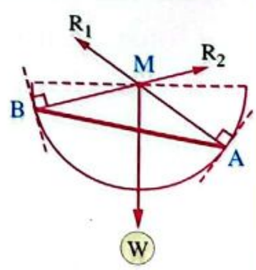
Y_1 (in direction of $\overrightarrow{AY}$)



5. The reaction of the smooth hemisphere on the rod rests on its surface is perpendicular to the rod and passes through the centre of the sphere.

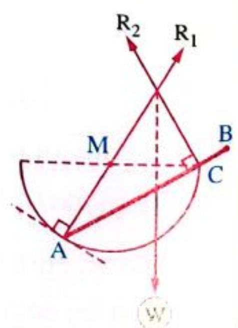


6. When a rod rests inside a smooth hemisphere , the reactions at its ends are perpendicular to the tangents at the points of contact and passes through the centre of the sphere and the rod will be settle in the position that makes the vertical line passing through the centre of the sphere passing also through the point of action of weight in the rod.



7. When a rod $\overline{AB}$ rests on the edge of a hemisphere by one of its points (C) , then:

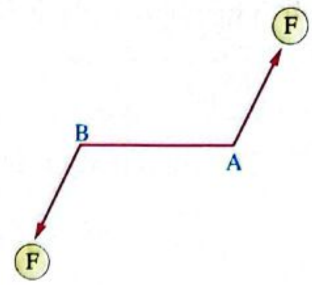
- The reaction at A is perpendicular to the tangent of the sphere at A.
- The reaction at C is perpendicular to the rod.



Couples

The couple is a system consists of two forces which are :

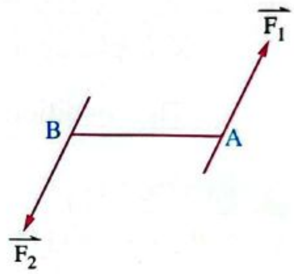
1. Equal in magnitude.
2. Opposite in direction.
3. Not on the same line of action.



The moment of a couple :

The moment of a couple is a constant vector , independent on the point about which we take the moment of the two forces and is equal to the moment of one of the forces of the couple about any point on the line of action of the other force.

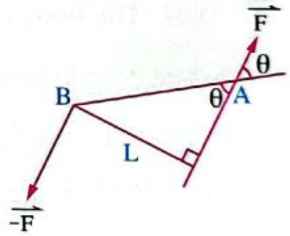
$\overrightarrow{M} = \overrightarrow{BA} \times \overrightarrow{F_1} = \overrightarrow{AB} \times \overrightarrow{F_2}$ where $\overrightarrow{F_1} = -\overrightarrow{F_2}$



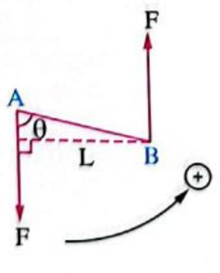
The magnitude of the moment of a couple :

$\| \overrightarrow{M} \| = BA \times F \times \sin\theta = F \times L$

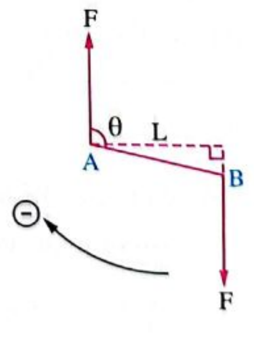
Where θ is the measure of the included angle between $\overrightarrow{BA}$, $\overrightarrow{F}$, L (the moment arm) is the perpendicular distance between the lines of actions of the two forces.



The algebraic measure of the moment of the couple :



$\boxed{M = F \times AB \sin\theta = F \times L}$



$\boxed{M = -F \times AB \sin\theta = -F \times L}$

Summary

The equilibrium of a rigid body under effect of two or more coplanar couples

- **The rigid body** is in equilibrium under effect of two couplanar couples $\overrightarrow{M_1}$, $\overrightarrow{M_2}$ if :

$$\boxed{\overrightarrow{M_1} + \overrightarrow{M_2} = \overrightarrow{O} \textit{ i.e. } \overrightarrow{M_1} = -\overrightarrow{M_2}}$$

- **The rigid body** is in equilibrium under effect of several couplanar couples

$\overrightarrow{M_1}$, $\overrightarrow{M_2}$, $\overrightarrow{M_3}$, ... , $\overrightarrow{M_n}$ if : $\boxed{\overrightarrow{M_1} + \overrightarrow{M_2} + \overrightarrow{M_3} + \cdots + \overrightarrow{M_n} = \overrightarrow{O}}$

Equivalence of two couples

- Two coplanar couples are equivalent if their moment vectors are equal.

i.e. The condition of equivalence of two coplanar couples $\overrightarrow{M_1}$, $\overrightarrow{M_2}$ is : $\boxed{\overrightarrow{M_1} = \overrightarrow{M_2}}$

Remarks

1. If a rigid body is in equilibrium under effect of some forces and a couple its algebraic moment (M) , then these forces have to form a couple its algebraic moment (– M)

   i.e. The body can't be in equilibrium under the effect of a force and couple.

2. The couple is only equivalent to another couple.

3. **The effect of the couple on rigid bodies depends on :**

   - The magnitude of its moment.
   - The plane in which its forces are lying.

   Therefore the effect of the couple on a rigid body does not change if its position in the plane changes to another position in the same plane when ever its moment does not change and its direction does not change.

   Also if it is replaced by another couple equivalent to it if it is in the same plane (or in other plane parallel to it)

Resultant couple

- The sum of any finite number of coplanar couples is called resultant couple and its moment equals the sum of their moments.

i.e. $\boxed{\overrightarrow{M} = \overrightarrow{M_1} + \overrightarrow{M_2} + \overrightarrow{M_3} + \cdots + \overrightarrow{M_n}}$

- If the resultant of system of coplanar forces = $\overrightarrow{R}$ and their moments about a point in their plane is $\overrightarrow{M}$ and

1. $\overrightarrow{R} = \overrightarrow{O}$, $\overrightarrow{M} = \overrightarrow{O}$, then the system is in equilibrium.
2. $\overrightarrow{R} = \overrightarrow{O}$, $\overrightarrow{M} \neq \overrightarrow{O}$, then the system is equivalent to a couple norm of its moment = $\| \overrightarrow{M} \|$

- If three (or more) coplanar forces not intersecting at a point act on a rigid body can be completely represented by the sides of a triangle taken in same cyclic order , then the system is equivalent to a couple , the magnitude of its moment equals twice the area of the triangle × m

  where m is constant equals $\dfrac{\text{The magnitude of a force}}{\text{The length of its corresponding side}}$

- If the sum of the algebraic measures of moments of system of coplanar forces about three non-collinear points lay in their plane is non-zero constant , then the system is equivalent to a couple whose algebraic measure of its moment equals this constant.

i.e. If system of coplanar forces act in the plane of three non-collinear points A , B , C and $M_A = M_B = M_C$ = non zero constant , then the system is equivalent to a couple its algebraic measure = the constant.

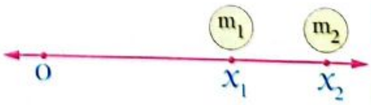
And if $M_A = M_B = M_C$ = zero , then the system is in equilibrium.

Centre of gravity

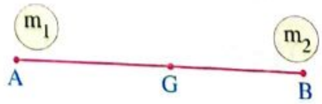
- The centre of gravity of a rigid body is a unique point in the space (except the centre of the earth), the line of action of its weight passes through it and it is fixed whatever the position of the body changes with respect to the surface of the earth.
  The centre of gravity of a rigid body denoted as (G)
- The line of action of the weight of rigid body passes through its centre of gravity and the centre of the earth.
- The centre of gravity of a rigid body is a fixed point with respect to the body but it is not necessary that it is at one of its particles.

Centre of gravity of two particles.

- Centre of gravity of two particles of masses m_1 , m_2 placed at positions x_1 , x_2 respectively with respect to an observer at (O) is $\boxed{x_G = \dfrac{m_1 x_1 + m_2 x_2}{m_1 + m_2}}$



- The centre of gravity (G) of two masses m_1 , m_2 at the two points A and B , where the distance between their centres of gravity is constant (L) lies on the line segment joining the two points and divides its length by inverse ratio to their masses. $\boxed{\dfrac{AG}{GB} = \dfrac{m_2}{m_1}}$



The position vector of centre of gravity of a rigid body with respect to origin

Let m_1 , m_2 , ... m_n be the masses of particles forming a rigid body , $\vec{r_1}$, $\vec{r_2}$, ... , $\vec{r_n}$ be position vectors of these particles with respect to the origin , then the position vector $\vec{r_G}$ to the centre of gravity of rigid body about the origin is determined by the relation

$$\vec{r_G} = \frac{m_1 \vec{r_1} + m_2 \vec{r_2} + ... + m_n \vec{r_n}}{m_1 + m_2 + ... + m_n}$$

and it can be written in terms of two components in directions of $\overrightarrow{OX}$, $\overrightarrow{Oy}$ as follow :

$$\boxed{x_G = \frac{m_1 x_1 + m_2 x_2 + ... + m_n x_n}{m_1 + m_2 + ... + m_n}} \quad , \quad \boxed{y_G = \frac{m_1 y_1 + m_2 y_2 + ... + m_n y_n}{m_1 + m_2 + ... + m_n}}$$

- A body of mass (m) and its centre of gravity position vector is $\vec{r_G}$ and we removed a part of mass (m_1) and its centre of gravity position vector is ($\vec{r_1}$) From it , then the centre of gravity position vector of the remaining part is $\vec{r_2}$ which is given by $\boxed{\vec{r_2} = \frac{m \vec{r_G} - m_1 \vec{r_1}}{m - m_1}}$

  where :

  and it can be written in terms of two components in directions of $\overrightarrow{OX}$, $\overrightarrow{Oy}$ as follow

$$\boxed{x_2 = \frac{m x - m_1 x_1}{m - m_1}} \; , \; \boxed{y_2 = \frac{m y - m_1 y_1}{m - m_1}}$$

Body with uniform density :

- It is a body in which the mass of unit length , or area or volume taken from any part of it is constant.

From that we deduce that :

- If the string (or rod) has uniform density , then its weight is proportional to its length.
- If a fine lamina has uniform density , then its weight is proportional to its area.
- For any fine lamina of uniform density , if it has an axis of symmetry , so its centre of gravity must be on this axis.
- For any body of uniform density , if it has a symmetric plane , so its centre of gravity must be in this plane.

The centre of gravity of a rigid body , freely suspended is on the vertical straight line passes through the suspension point.

Centre of gravity of some simple rigid bodies :

1. The centre of gravity of a uniform density rod lies at its midpoint.
2. The centre of gravity of a uniform density thin lamina in shape of parallelogram or one of its special cases (square - rectangle - rhombus) lies at its geometrical centre (point of intersection of its diagonals).
3. The centre of gravity of a uniform density lamina in triangular shape lies at point of concurrent of its medians (it is the point which divides each median internally in 1 : 2 from the base)
4. The centre of gravity of a uniform thin wire in shape of a triangle does not lie at the point of concurrence of medians unless the triangle is an equilateral triangle.
5. The centre of gravity of a uniform density lamina in a circular shape is at the centre of the circle.
6. The centre of gravity of a uniform density lamina in shape of regular hexagon lies at the centre of the hexagon.
7. The centre of gravity of a wire of a uniform density in the form of a circle lies at its centre.
8. The centre of gravity of a spherical crust (cortex) of a uniform density lies at its centre.
9. The centre of gravity of a solid sphere of uniform density lies at its centre.
10. The centre of gravity of a solid of a uniform density in the form of a cuboid lies at its geometrical centre.
11. The centre of gravity of a right circular cylinderical crust of a uniform density lies at the midpoint of the altitude joining the centres of its two bases.
12. The centre of gravity of a solid right circular cylinder of a uniform density lies at the midpoint of the altitude joining the centres of its two bases.
13. The centre of gravity of a uniform right prism lies at the midpoint of the line segment parallel to its lateral edges and passing through the two centres of gravity of its two bases considering them as two fine lamina of uniform densities.

Important remark

The centre of gravity of a uniform triangular lamina coincides with the centre of gravity of three equal masses placed at its vertices.

Multiple Choice Question Bank

in

Statics

First Questions on friction

1 Choose the correct answer from the given ones :

1. The relation between the coefficient of static friction (μ_s) and the angle of friction (λ) is given by the relation ....

   (a) $\mu_s = \cos\lambda$ (b) $\mu_s = \sin\lambda$ (c) $\mu_s = \tan\lambda$ (d) $\mu_s = \cot\lambda$

2. The angle of friction is the angle between .... when friction is limiting.

   (a) the resultant reaction and the limiting static friction
   (b) the resultant reaction and the normal reaction
   (c) the resultant reaction and the weight of the body
   (d) the normal reaction and the static friction

3. The coefficient of static friction is ....

   (a) a force acts against the force acting on the body.
   (b) the resultant of the normal reaction and friction.
   (c) the ratio between the magnitude of the limiting friction to the magnitude of the normal reaction.
   (d) the ratio between the magnitude of the resultant reaction to the magnitude of the limiting friction.

4. The static frictional force is less than or equal to the product of the coefficient of static friction × ....

   (a) the normal reaction.
   (b) the resultant reaction.
   (c) the body weight.
   (d) the tangential force trying to move the body.

5 The coefficient of friction between two bodies depends on .... of the bodies in contact.

(a) the shape (b) the weight (c) the volume (d) the nature

---

6 If μ_s , μ_k are static and kinetic coefficients of friction respectively of two bodies touching each other , then ....

(a) $\mu_s = \mu_k$ (b) $\mu_s < \mu_k$ (c) $\mu_s > \mu_k$ (d) $\mu_s + \mu_k = 1$

---

7 If F_k is the kinetic frictional force , μ_k is the kinetic coefficient of friction and R is the normal reaction , then ....

(a) $\mu_k = \frac{F_k}{R}$ (b) $\mu_k = \frac{R}{F_k}$ (c) $F_k = R + \mu_k$ (d) $F_k = \frac{\mu_k}{R}$

---

8 The dimensions of a cuboid box are 30 cm. , 40 cm. , 50 cm. its required to drag on a rough horizontal ground , the coefficient of friction between the box and the ground is $\frac{1}{4}$, which face should placed on the ground to drag the box with the least force ?

(a) on the face whose dimensions 30 cm. , 40 cm.

(b) on the face whose dimensions 40 cm. , 50 cm.

(c) on the face whose dimensions 30 cm. , 50 cm.

(d) the force does not depend on the area of contact with the ground.

---

9 The resultant reaction is the resultant of .... when the body is about to move.

(a) the weight of the body and the normal reaction.

(b) the weight of the body and the limiting static friction.

(c) the normal reaction and the limiting static friction.

(d) the kinetic friction and the normal reaction.

---

10 Tangent of the angle between the normal reaction and the resultant reaction at the limiting friction is called ....

(a) angle of static friction. (b) coefficient of static friction.

(c) the friction force. (d) the limiting friction force.

---

11 If θ is the measure of the angle between the normal reaction and the resultant reaction when the friction is limiting and 2 θ is the measure of the angle between the resultant reaction and the limiting static friction , then the coefficient of static friction = ...

(a) $\frac{\sqrt{3}}{3}$ (b) $\sqrt{3}$ (c) $\frac{\sqrt{3}}{2}$ (d) $\frac{1}{3}$

12. If a body is placed on a rough plane inclined to the horizontal at an angle of measure θ and the body was about to move under effect of its weight only , then the angle of friction = ...

(a) $\tan^{-1}\theta$ (b) θ (c) $\tan\theta$ (d) 2θ

---

13. If a body is placed on a rough inclined plane and it was about to slide , then the tangent of the angle of friction is equal to each of the following except ....

(a) coefficient of static friction.
(b) the ratio between the magnitude of the normal reaction and the magnitude of the resultant reaction.
(c) tangent of the angle between the plane and the horizontal.
(d) the ratio between the magnitude of the limiting friction and the magnitude of the normal reaction.

---

14. A body of weight 10 N. is placed on a rough plane inclined to the horizontal at an angle of measure θ , the body is about to move under action of its weight only. If another body made of the same material , and of weight 20 N. is placed on the same inclined plane , then the second body will ....

(a) be about to move down.
(b) be in equilibrium but it is not about to move.
(c) slide downward.
(d) be about to move up.

---

15. The magnitude of a horizontal force is 5 kg.wt. It acts on a body of weight 15 kg.wt. the body is placed on a horizontal rough plane. If the body is about to move , then the coefficient of static friction between the body and the plane = ...

(a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) 3 (d) 10

---

16. A boy pushes a stone of weight 56 newton by a horizontal force of magnitude 42 newton on a sidewalk , the stone was about to move , then the coefficient of static friction between the stone and the sidewalk = ...

(a) $\frac{1}{2}$ (b) $\frac{1}{4}$ (c) $\frac{3}{4}$ (d) 1

---

17. Wael pushes a box of books to his car on a rough horizontal plane. The weight of the box and the books is 80 N. and the coefficient of static friction between the box and the plane is 0.25 , then the horizontal force that Wael can use to make the box about to move equals .... N

(a) 20 (b) 60 (c) 80 (d) 320

18 A body of weight (W) kg.wt. is placed on a rough horizontal plane and the coefficient of static friction between the body and the plane = $\frac{2}{5}$
If a horizontal force of magnitude 45 kg.wt. acts on the body and make it about to move , then the weight of the body = ... kg.wt.

(a) 22.5 (b) 90 (c) 112.5 (d) 225

19 A body of weight 80 N. is placed on a rough horizontal plane , the coefficient of static friction between the body and the plane = $\frac{3}{4}$, a horizontal force of magnitude 50 N. acts on it. , then the ratio between the friction force and the limiting friction = ...

(a) 3 : 4 (b) 3 : 5 (c) 5 : 6 (d) 6 : 5

20 If the coefficient of static friction between the body and the plane = 2 sin 30° , then measure of angle of friction = ...

(a) 30° (b) 45° (c) 60° (d) 90°

21 If magnitude of the limiting frictional force is 30 newtons , the magnitude of the resultant reaction is 50 newtons , then the static coefficient of friction equals ....

(a) $\frac{9}{16}$ (b) $\frac{3}{4}$ (c) $\frac{4}{5}$ (d) $\frac{4}{3}$

22 A horizontal force of magnitude 98 N. makes a body of mass 100 kg. tends to move on a horizontal ice surface , then the coefficient of friction = ...

(a) 0.98 (b) 0.4 (c) 0.2 (d) 0.1

23 If magnitude of the limiting friction force is 60 newton and coefficient of friction is 0.75 , then magnitude of resultant reaction equals .... newtons.

(a) 60 (b) 80 (c) 100 (d) 200

24 A body of weight $2\sqrt{3}$ kg.wt. is placed on a rough horizontal plane , a horizontal force of magnitude 2 kg.wt. acts on it and makes the body about to move , then the magnitude of the resultant reaction = ... kg.wt.

(a) 2 (b) 8 (c) 4 (d) $8\sqrt{3}$

25 A body of weight 30 N. is placed on a rough horizontal plane. A horizontal force of magnitude 20 N. acts on it. If the coefficient of static friction between the body and the plane = $\frac{3}{4}$, then the body will ....

(a) be in equilibrium and not about to move.
(b) be in equilibrium and about to move.
(c) have a frictional force = 22.5
(d) move in the direction of the force.

26 A body of weight 14 kg.wt. is placed on a horizontal rough plane. When the body is pulled by a horizontal force of magnitude 7 kg.wt. , it became about to begin motion.
If a weight of 6 kg.wt. is placed on the body , then the magnitude of the horizontal force which makes the body and the weight be about to begin motion = ... kg.wt.

(a) 5 (b) 10 (c) 15 (d) 21

---

27 A body of weight 20 N. is placed on a rough horizontal plane.
The coefficient of static friction between the body and the plane = $\frac{\sqrt{3}}{4}$. The force which inclined to the horizontal upward at an angle of measure 30° and it makes the body about to move = ... newtons.

(a) $5\sqrt{3}$ (b) $10\sqrt{3}$ (c) 16 (d) 8

---

28 If the coefficient of static friction between a body and an inclined rough plane equals $\sqrt{3}$, then the measure of the inclination angle of the plane to the horizontal when the body is about to slide under effect of its weight only = ...

(a) 30° (b) 45° (c) 60° (d) 75°

---

29 A body is placed on a rough inclined plane makes an angle of measure $\sin^{-1} \frac{5}{13}$ and it was about to slide under effect of its weight only , then the coefficient of static friction between the body and the plane equals ....

(a) $\frac{5}{13}$ (b) $\frac{5}{12}$ (c) $\frac{12}{13}$ (d) $\frac{12}{5}$

---

30 A body of weight 6 N. was placed on a rough inclined plane so it was about to slide if magnitude of the limiting friction was $3\sqrt{3}$ N. , then the measure of the inclination angle of the plane to the horizontal equals ....°

(a) 30 (b) 45 (c) 60 (d) 90

---

31 A body is placed on a rough plane inclined to horizontal at an angle equals the measure of the friction angle , then the body ....

(a) is at rest on the plane. (b) moves on the plane.
(c) is about to move downward the plane. (d) is about to move upwards the plane.

---

32 If a body is placed on a rough plane and the measure of inclination angle of the plane to the horizontal is less than the measure of angle of friction , then the body ....

(a) remains at rest on the plane. (b) moves upwards the plane.
(c) moves downwards the plane. (d) is about to move on the plane.

33 If a body is placed on a rough plane and the measure of inclination angle of the plane with the horizontal is greater than the measure of the angle of friction , then the body ....

(a) remains at rest on the plane.
(b) moves on the plane.
(c) is about to move down the plane.
(d) is about to move up the plane.

---

34 A body of mass 4 kg. is placed on a rough inclined plane makes an angle of measure 30° with the horizontal and the coefficient of friction between the body and the plane is $\frac{\sqrt{3}}{2}$ the body ....

(a) is about to move up the plane.
(b) is about to move down the plane.
(c) moves on the plane.
(d) remains at rest.

---

35 A body is placed on a rough inclined plane and the angle of friction between the body and the plane is λ , the plane makes an angle of measure θ , then the body is in equilibrium if and only if ....

(a) $\theta > \lambda$
(b) $\theta \geq \lambda$
(c) $\theta \leq \lambda$
(d) $\theta = 2\lambda$

---

36 A body is placed on a rough inclined plane it makes an angle of measure θ to the horizontal. The coefficient of static friction between the body and the plane is $\frac{\sqrt{3}}{3}$, if the body is in equilibrium on the plane , then ....

(a) $\theta = 30°$
(b) $\theta > 30°$
(c) $\theta \leq 30°$
(d) $\theta \geq 30°$

---

37 If a body is placed on a rough inclined plane makes an angle of measure 30° to the horizontal , so immediately it slides downward , then ....

(a) the angle of friction = 30°
(b) the coefficient of static friction $\mu_s < \frac{\sqrt{3}}{3}$
(c) the coefficient of kinetic friction $\mu_k > \frac{\sqrt{3}}{3}$
(d) the body weight equals the kinetic friction force.

---

38 A body of mass 10 kg. is placed on a rough plane inclined to the horizontal at an angle of measure 30° and the body is about to move , then the force parallel to the plane and makes the body about to move up the plane P = ... kg.wt.

(a) 5
(b) 10
(c) 15
(d) 20

39 If λ is the measure of the angle of friction , then the resultant reaction $\grave{R}$ = ... where R is the normal reaction of the plane to the body.

(a) $R\sqrt{1+\tan\lambda}$ (b) $R\sqrt{1+\sec\lambda}$ (c) $R\tan\lambda$ (d) $R\sec\lambda$

40 If λ is the measure of the angle between force of limiting friction and resultant reaction , then μ (the coefficient of static friction) = ...

(a) $\tan\lambda$ (b) $\sin\lambda$ (c) $\cos\lambda$ (d) $\cot\lambda$

41 A body of weight 6 N. is placed on a rough horizontal plane , the coefficient of friction between them is $\frac{1}{\sqrt{3}}$, a vertical force of magnitude $2\sqrt{3}$ N. acts on the body downward , then ....

(a) the body is about to move. (b) the friction force is $2\sqrt{3}$ N.

(c) the friction force = zero (d) the body will move under action of this force.

42 A body of weight (W) is placed on a horizontal rough plane its angle of friction is (λ) , then least force makes the body about to move on the plane equals ....

(a) $W\sin\lambda$ (b) $W\cos\lambda$ (c) $W\tan\lambda$ (d) $W\csc\lambda$

43 If a body of weight (W) is placed on a rough horizontal plane , its angle of friction is (λ) , then the greatest horizontal force act on it and the body stay in equilibrium is ....

(a) $W\tan\lambda$ (b) $W\sin\lambda$ (c) $W\cos\lambda$ (d) $W\sec\lambda$

44 A body of mass m kg. is placed on a rough horizontal plane. The coefficient of friction between the body and the plane = $\frac{1}{\sqrt{3}}$. Force of magnitude 10 kg.wt. acts on the body , the force makes an angle of measure 30° above the horizontal and the body becomes about to move then m = ... kg.

(a) 5 (b) 10 (c) 15 (d) 20

45 A body of weight 10 kg.wt. is placed on a rough horizontal plane. The coefficient of static friction between the body and the plane is $\frac{2}{5}$. If a horizontal force of magnitude (F) kg.wt. acts on the body that the body is no longer in equilibrium on the plane , then F can be equal .... kg.wt.

(a) 2 (b) 3 (c) 4 (d) 5

46 A body of weight 250 gm.wt. is placed on a rough horizontal plane. The coefficient of static friction between the body and the plane = $\frac{3}{5}$. The body is tied to a string which passes over a small smooth pulley fixed at the edge of the plane and from the other end of the string a scale pan of weight 60 gm.wt. is hanged , then the weight should be placed on the scale pan in order to make the system about to move is .... gm.wt.

(a) 75 (b) 90 (c) 120 (d) 150

---

47 A body of weight (W) newton is placed on a rough horizontal plane.

The coefficient of static friction between the body and the plane equals $\frac{\sqrt{3}}{3}$

A force of magnitude (F) N. acts on the body. If the body stays at rest , then measure of the angle between the resultant reaction and the normal reaction $\in$ ....

(a) $\{\frac{\pi}{4}\}$ (b) $\{\frac{\pi}{3}\}$ (c) $]0 , \frac{\pi}{6}]$ (d) $]0 , \frac{\pi}{3}]$

---

48 A body is placed on a rough horizontal plane, λ is the measure of angle of friction between the body and the plane. A horizontal force $\vec{F}$ acts on the body where $F = 2 \tan \lambda - \sin 2\lambda$, if the body becomes at the point of moving , then the weight of the body = ...

(a) $\sin (2\lambda)$ (b) $2 \sin (\lambda)$ (c) $2 \sin^2 (\lambda)$ (d) $2 \tan (\lambda)$

---

49 A body is placed on an inclined rough plane and it was about to slide. When the inclination angle to the horizontal is increased, the body moved downward , then the friction force at this moment ....

(a) vanished. (b) decreases.

(c) increases. (d) increases to infinity.

---

50 A body of weight 21 newtons is placed on a horizontal rough plane. Two horizontal forces act on its , the magnitudes of these forces are 3 , 5 newtons and measure of the angle between them is 60° , the body becomes about to move , then the coefficient of static friction = ...

(a) 3 (b) $\frac{1}{3}$ (c) 7 (d) $\frac{1}{7}$

---

51 A body of weight 40 kg.wt. is placed on a horizontal rough plane , two perpendicular forces of magnitudes 6 and 8 kg.wt. acted horizontally on the body , the body stayed in equilibrium , then the coefficient of static friction ....

(a) $\mu_s \leq \frac{1}{4}$ (b) $\mu_s \geq \frac{1}{4}$ (c) $\mu_s < \frac{1}{4}$ (d) $\mu_s = \frac{1}{4}$

52 A body of weight 52 N. is placed on a rough horizontal plane. The coefficient of static friction between the body and the plane = $\frac{1}{4}$. Two horizontal forces of magnitudes 8 N. , P N. including an angle of measure 60° act on it. Then the body will be about to move if P = ... newtons.

(a) 7 (b) 8 (c) 13 (d) 15

---

53 Three bodies of weights W_1 , W_2 , $W_1 + W_2$, made of the same material , are placed on a rough horizontal plane , forces of magnitudes F_1 , F_2 , F_3 act on them respectively and make the bodies tend to move then ....

(a) $F_3 = F_1 + F_2$ (b) $\frac{1}{F_3} = \frac{1}{F_1} + \frac{1}{F_2}$ (c) $F_3 = F_1 F_2$ (d) $F_3 = \frac{F_1 + F_2}{F_1 F_2}$

---

54 A body of weight 4 kg.wt. is placed on a rough plane inclined to the horizontal at an angle of measure 45°. The coefficient of static friction between them is $\mu_s = \frac{1}{2}$, then the greatest force can preserve the body equilibrium acting in direction of the line of the greatest slope of the plane is .... kg.wt.

(a) $3\sqrt{2}$ (b) $2\sqrt{2}$ (c) $\sqrt{2}$ (d) $\frac{1}{\sqrt{2}}$

---

55 A body of weight 10 N. is placed on a rough plane inclined to the horizontal at an angle of measure θ , the body is about to move under action of its weight only. If another body made of the same material , and of weight 20 N. is placed on the same inclined plane , then the second body will ....

(a) be about to move down.

(b) be in equilibrium but it is not about to move.

(c) slide downward.

(d) be about to move up.

---

56 A body of weight 6 kg.wt. is placed on a rough plane inclined to the horizontal at an angle of measure 30° , the body was about to slide and if the inclination angle of the plane is increased to be 60° , then the least force can preserve the body in equilibrium and acts in direction of the line of greatest slope up the plane is .... kg.wt.

(a) 3 (b) $2\sqrt{3}$ (c) $\sqrt{3}$ (d) $3\sqrt{3}$

57 A body of weight 15 newtons is placed on a rough plane inclined to the horizontal at an angle its sine is $\frac{3}{5}$. The body is pulled with a force of magnitude 13 newtons acts parallel to the line of greatest slope of the plane upward. The body is about to move upward , then the coefficient of static friction between the body and the plane = ...

(a) $\frac{1}{3}$ (b) $\frac{1}{4}$ (c) $\frac{3}{4}$ (d) $\frac{13}{15}$

---

58 A body of weight 30 N is placed on a rough inclined plane , it is notice that the body is about to move when the plane is inclined to the horizontal by an angle $\sin^{-1}\frac{5}{13}$, if the inclination of the plane to the horizontal is increased to angle $\sin^{-1}\frac{3}{5}$, then the least force which acts on the body parallel to the line of the greatest slope , prevent the body from sliding = ... N.

(a) 8 (b) 10 (c) 12 (d) 15

---

59 A body of weight (W) is placed on a rough inclined plane makes an angle of sine $\frac{5}{13}$ with the horizontal. The body is attached by a horizontal force of magnitude 22 newtons lies in the vertical plane which passes through the line of the greatest slope and makes the body about to move upwards the plane , if the static coefficient friction between the body and the plane is $\frac{1}{2}$, then the magnitude of the weight (W) = ... N.

(a) 15 (b) 17 (c) 19 (d) 21

---

60 A body of weight 25 newtons rests on a rough plane inclined to the horizontal at an angle of measure $\cos^{-1}\frac{4}{5}$ and coefficient of friction between the body and the plane is $\frac{1}{5}$. If force (P) acts on the body in direction of line of the greatest slope upwards and preserves the body in equilibrium , then which of the following must be true about F in newton ?

(a) $3 \leq P \leq 4$ (b) $P = 19$ (c) $P = 11$ (d) $11 \leq P \leq 19$

---

61 A body of weight 8 kg.wt. is placed on a rough plane which is inclined to the horizontal at an angle of measure 45° , it is noticed that the least horizontal force acting on the body to keep it in equilibrium is 4 kg.wt. then the greatest magnitude of this force = ... kg.wt..

(a) 12 (b) 16 (c) 20 (d) 24

---

62 A body of weight (W) N. is placed on a rough inclined plane. The plane makes an angle of measure (θ) to the horizontal. The coefficient of friction between the body and the plane equals (μ) , then the tangential force that acts on the body and makes the friction vanished equals .... N.

(a) μ W (b) $\mu \cos \theta$ (c) $\mu W \cos \theta$ (d) $W \sin \theta$

63 A body of weight (W) N. is placed on a rough plane inclined to the horizontal at an angle of measure θ. The coefficient of friction between the body and the plane equals μ. Force of magnitude (P = W sin θ) acts on the body in direction of the line of the greatest slope of the plane upward , then the magnitude and direction of the friction are ....

(a) μ W cos θ upward.
(b) μ W cos θ downward.
(c) zero
(d) μ (R – W sin θ) upward.

64 A body of weight (W) is placed on a rough plane inclined to the horizontal at an angle of measure (θ). If the angle of friction between the body and the plane is (λ) , then the least force makes the body about to move up equals ....

(a) W sin (θ + λ)
(b) 2 W sin (θ – λ)
(c) W sin (θ – λ)
(d) 2 W sin (θ + λ)

65 When a weight W is placed on a rough inclined plane at an angle of measure θ to the horizontal and the weight is about to slide down , then the least force (P) acting along the line of the greatest slope and makes the weight about to move upwards is equal to ....

(a) W sin θ
(b) W cos θ
(c) 2 W sin θ
(d) 2 W tan θ

66 A body of weight (W) is placed on a rough inclined plane makes with the horizontal an angle of measure θ and a force of magnitude (W) acts on it in direction of the line of greatest slope of the plane and the body is about to move up , then μ_s + tan θ = ...

(a) sec θ
(b) csc θ
(c) sin θ
(d) cos θ

67 A body of weight (W) gm.wt. is placed on a horizontal rough plane. A horizontal force of magnitude 100 gm.wt. acts on it. It makes it about to move. The plane has been tilted 45° to the horizontal and force of magnitude $150\sqrt{2}$ gm.wt. acts on the body in direction of the line of greatest slope up , the body now is about to slide , then the coefficient of static friction between the body and the plane = ...

(a) $\frac{3}{4}$
(b) $\frac{1}{2}$
(c) $\frac{1}{4}$
(d) $\frac{1}{\sqrt{2}}$

68 A body of weight (W) N. is placed on a rough horizontal plane. The coefficient of static friction between the body and the plane = μ_s If the horizontal force which makes the body about to move is P N. , given P < W , then ....

(a) $\mu_s > 1$
(b) $\mu_s = 1$
(c) $0 < \mu_s < 1$
(d) $\mu_s \geq 1$

69 A body of weight 200 gm.wt. is placed on a rough inclined plane. Force F acts on it in direction of line of the greatest slope of the plane. The body is about to move down the plane when F = 80 gm.wt. and the body is about to move up the plane if F = 120 gm.wt. , then the measure of the inclination angle of the plane with the horizontal = ...

(a) $22\frac{1}{2}$ (b) 30° (c) 45° (d) 60°

---

70 A body of weight 50 N. is placed on a rough plane which inclined to the horizontal at angle of measure θ. If the least and greatest forces which applied parallel to the line of greatest slope and makes the body in equilibrium on the plane are 10 N. , 40 N. respectively , then the coefficient of static friction = ...

(a) $\frac{\sqrt{3}}{5}$ (b) $\frac{\sqrt{3}}{4}$ (c) $\frac{\sqrt{3}}{3}$ (d) $\frac{\sqrt{3}}{2}$

---

71 A body of weight (W) is placed on a rough inclined plane at an angle of measure θ to the horizontal. Force P acts on the body in direction of the line of greatest slope of the plane upward. If the body is about to move when $P = \frac{2}{5}$ W N. or $P = \frac{4}{5}$ W N. , then $\tan\theta : \tan\lambda$ = ...

(a) 2 : 1 (b) 3 : 2 (c) 1 : 3 (d) 3 : 1

---

72 A 130 newton weight is placed on a plane which is inclined to the horizontal with an angle whose cosine is $\frac{5}{13}$ and there is a force applied to the weight parallel to the line of the greatest slope upwards. If the coefficient of static friction between the weight and the plane is $\frac{2}{5}$, then the limits between which the applied force lies , so as to make the weight in equilibrium on the plane are .... , ... N

(a) 80 , 100 (b) 100 , 120 (c) 120 , 140 (d) 100 , 140

---

73 A body of weight $66\frac{2}{3}$ newton is placed on a horizontal rough plane , the coefficient of friction between the body and the plane is $\frac{3}{4}$, a force of magnitude 40 newton acts on it and makes an acute angle of measure θ above the horizontal , if the body is about to move , then the value of $\theta \simeq$ ....

(a) $36°\ 52'$ (b) $53°\ 8'$ (c) $73°\ 44'$ (d) $18°\ 26'$

---

74 A body of weight 3 newton is placed on a horizontal rough plane whose friction coefficient with the body is $\frac{1}{3}$, A horizontal force acts on it , trying to move it , then the magnitude of the friction force $\in$ ....

(a) $[\frac{1}{3} , 3]$ (b) $[1 , \infty[$ (c) $]0 , 1]$ (d) $[0 , \frac{1}{3}]$

75 A body of weight 1 newton is placed on a horizontal rough plane , the coefficient of friction between it and the body is $\sqrt{3}$, a horizontal force acted on it trying to move it , then the magnitude of the resultant reaction force $\in$ ....

(a) $]0 , 1]$ (b) $]1 , 2]$ (c) $\{1 , 2\}$ (d) $\{2\}$

---

76 A body of weight (W) newton is placed on a rough horizontal plane. The coefficient of static friction between the body and the plane = $\frac{1}{4}$. A horizontal force acts on the body to move it such that the friction force $\in]0 , 4]$, then W = ... N.

(a) 1 (b) 4 (c) 8 (d) 16

---

77 A body of weight (W) is about to move on a rough horizontal plane by a horizontal force of magnitude (P) , the coefficient of static friction between the body and the plane is μ , then another body of weight (W + 3) made of the same material would be about to move on the same horizontal plane if a horizontal force of magnitude .... acts on it.

(a) $P + 3$ (b) $3 P$ (c) P^3 (d) $P + 3\mu$

---

78 A horizontal force $\vec{P}$ acts on a body of weight (W_1) placed on a rough horizontal plane , it makes the body about to move. If the same force $\vec{P}$ acts on another body of weight (W_2) placed on the same horizontal plane and makes it also about to move and the coefficient of static friction between the bodies and the plane are μ_1 , μ_2 respectively. So which of the following statements is true ?

(a) $W_1 = W_2$ (b) $\mu_1 = \mu_2$

(c) $\frac{W_1}{W_2} = \frac{\mu_2}{\mu_1}$ (d) $W_1 + \mu_1 = W_2 + \mu_2$

---

79 Two bodies of weights W_1 and W_2 are connected by a light string coinciding on the line of the greatest slope of a rough plane , the two coefficients of static friction between the two bodies and the plane are μ_1 and μ_2 respectively. If θ is the measure of the angle of inclination of the plane to the horizontal , and this measure increases gradually. Show which of the two bodies should be placed below the other in order to make the bodies move together while the string is taut when the two bodies are about to slide ?

(a) The heavier body.

(b) The lighter body.

(c) The body with greater coefficient of friction.

(d) The body with smaller coefficient of friction.

80 If a horizontal force (P) acts on a body of weight (W) placed on a rough horizontal plane the angle of friction is λ and the body was about to move , then the resultant reaction $(\grave{R})$ = ...

(a) $W \tan \lambda$ (b) $W \csc \lambda$ (c) $P \csc \lambda$ (d) $P \sin \lambda$

---

81 Two bodies made of different materials their weights are W_1 , W_2 are placed on a rough inclined plane makes with the horizontal an angle of measure θ and the coefficient of friction between the plane and the two bodies are μ_1 , μ_2 respectively. If the two bodies were about to move , then ....

(a) $W_1 = W_2$ (b) $\mu_1 = \mu_2$

(c) $W_1 \mu_1 = W_2 \mu_2$ (d) $W_1 \sin \theta = W_2 \cos \theta$

---

82 A body of weight 8 kg.wt. is placed on a rough inclined plane makes with the horizontal an angle of measure 30°. The coefficient of friction between the body and the plane $\mu_s = \frac{1}{2\sqrt{3}}$ Force P acts on it in direction of the line of greatest slope of the plane , then :

First : P kg.wt. which makes the body about to move $\in$ ....

(a) {2} (b) {6} (c) {2 , 6} (d) [2 , 6]

Second : P kg.wt. which keeps the body in equilibrium $\in$ ....

(a) {2} (b) {6} (c) {2 , 6} (d) [2 , 6]

---

83 If a body of weight (W) is placed on a rough plane inclined to the horizontal at an angle of measure θ and P_1 , P_2 are the greatest and the smallest forces acting in direction of the line of greatest slope of the plane up and keep the body in equilibrium F_s is the limiting static friction , then :

First : $P_1 + P_2$ = ...

(a) $2 W \sin \theta$ (b) $W \sin \theta$ (c) $2 W \cos \theta$ (d) $2 \mu_s R$

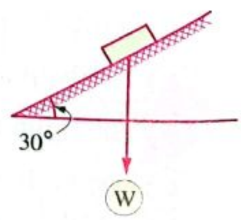
Second : $P_1 - P_2$ = ...

(a) $2 W \sin \theta$ (b) $2 W \sin \theta + F_s$ (c) $2 F_s$ (d) $W \sin \theta - F_s$

2 Choose the correct answer from the given ones :

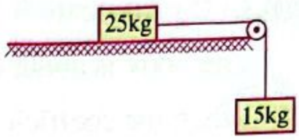
1 **In the opposite figure :**

If the body is about to slide under effect of its weight only , then the coefficient of static friction between the body and the plane = ...



(a) sin 30° (b) cos 30° (c) tan 30° (d) cot 30°

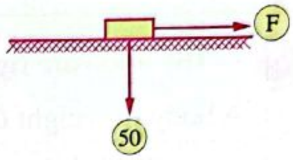
2 **In the opposite figure :**



The pulley is smooth , the horizontal plane is rough , the system is about to move , then the coefficient of static friction = ...

(a) $\frac{3}{4}$ (b) $\frac{3}{5}$ (c) $\frac{4}{5}$ (d) $\frac{5}{3}$

3 ***(Trial 2021)*** **In the opposite figure :**

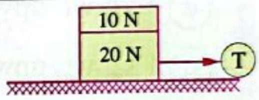


A body of weight 50 kg.wt. is placed on a rough horizontal plane. A horizontal force of magnitude F kg.wt. acts on it and makes the body about to move.

If the sine of angle of friction equals $\frac{3}{\sqrt{34}}$, then F = ... kg.wt.

(a) $25\sqrt{34}$ (b) $50\sqrt{34}$ (c) 30 (d) 50

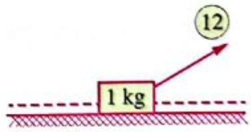
4 A body consists of two parts their weights are 20 N. , 10 N. , are placed as shown in the figure , a horizontal force T acts on it and makes the body about to move , if the upper body of weight 10 N. is removed and the tension is still acting as it was , then the body ....



(a) moves in the tension direction. (b) stays about to move.

(c) stays at rest. (d) moves in the opposite direction of tension.

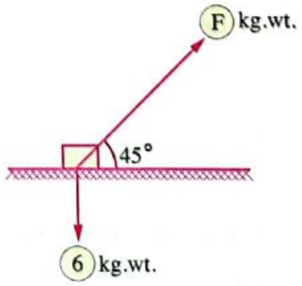
5 **In the opposite figure :**



A brick of mass 1 kg. is in equilibrium on a horizontal rough plane. A force of magnitude 12 newtons inclined to the horizontal at an angle of measure 30° acted on it if the body is about to move , then the coefficient of static friction between the body and the plane = ...

(a) $\frac{30\sqrt{3}}{19}$ (b) $\frac{7}{6\sqrt{3}}$ (c) $\frac{1}{12}$ (d) $\frac{5}{6\sqrt{3}}$

6 **In the opposite figure :**



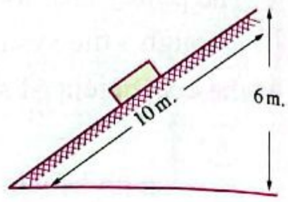
A body of weight 6 kg.wt. is placed on a rough horizontal plane , the coefficient of static friction between the body and the plane is $\frac{1}{2}$. A force of magnitude F kg.wt. acts on it and inclined at an angle 45° to the horizontal. If the body is about to move , then F = ... kg.wt.

(a) $2\sqrt{2}$ (b) $3\sqrt{2}$ (c) $\frac{3}{\sqrt{2}}$ (d) $\frac{3\sqrt{2}}{2}$

7 **In the opposite figure :**

The body is about to slide downwards

, then the coefficient of static friction = ...



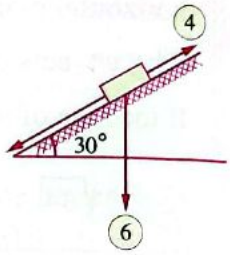
ⓐ $\frac{3}{5}$ ⓑ $\frac{4}{5}$

ⓒ $\frac{3}{4}$ ⓓ $\frac{4}{3}$

---

8 **In the opposite figure :**

A body of weight 6 kg.wt. is placed on a rough inclined plane. It is kept in equilibrium by a force P of magnitude 4 kg.wt. acting in direction of the line of greatest slope of the plane upward , then the magnitude and direction of the friction are ....

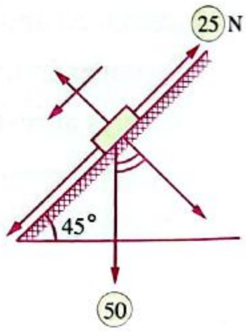


ⓐ 4 kg.wt. upward. ⓑ 3 kg.wt. downward.

ⓒ 1 kg.wt. upward. ⓓ 1 kg.wt. downward.

---

9 A body of weight 50 newtons is placed on a rough inclined plane makes an angle 45° with the horizontal as shown in the figure. Force of magnitude 25 newtons acts on the body in direction of the line of the greatest slope of the plane upward. The body is about to move down the plane then the coefficient of static friction between the body and the plane equals ....



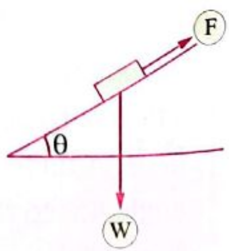
ⓐ $\frac{\sqrt{2}}{2}$ ⓑ $\frac{\sqrt{2}-1}{2}$

ⓒ $1-\frac{\sqrt{2}}{2}$ ⓓ $\sqrt{2}-1$

---

10 ***(1st Session 2021)*** **In the opposite figure :**

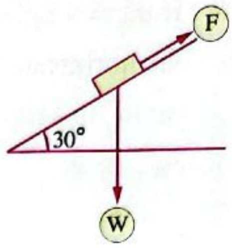
A body of weight (W) newton is placed on a rough plane inclined to the horizontal with an angle of measure θ. If a force $\vec{F}$ in the direction of the line of the greatest slope of the plane upward acts on the body to make it about to move upwards the plane when the measure of the angle of friction is θ , then the magnitude of the resultant reaction force $\grave{R}$ = ... newton.



ⓐ W sin θ ⓑ W cos θ ⓒ W tan θ ⓓ W

11 *(2^{nd} Session 2021)* **In the opposite figure :**

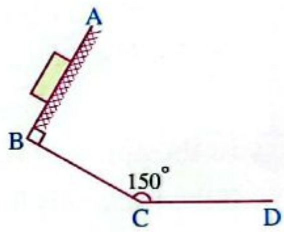
A body of weight (W) newton is placed on a rough plane inclined to the horizontal by an angle of measure 30° , a force of magnitude F newton in the direction of the line of the greatest slope upwards the plane acts on it to make the body about to move upwards when the magnitude of the resultant reaction between the body and the plane equals (W) newton , then F = ... newton.



(a) W (b) $\frac{\sqrt{3}}{2}$ W (c) $\frac{1}{2}$ W (d) $\sqrt{3}$ W

12 **In the opposite figure :**

$\overline{DC}$ is a horizontal plane , $\overline{AB}$ is an inclined plane. If the body on the plane $\overline{AB}$ at the point of sliding , then the coefficient of friction between them is ....

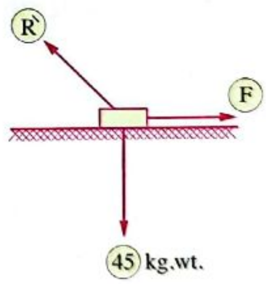


(a) $\sqrt{3}$ (b) $\frac{1}{\sqrt{3}}$

(c) $\frac{1}{2}$ (d) $\frac{1}{2\sqrt{3}}$

13 **In the opposite figure :**

A body of weight 45 kg.wt. is placed on a rough horizontal plane. The coefficient of static friction between the body and the plane = $\frac{\sqrt{3}}{3}$ If the body is about to move , then $F + \vec{R}$ = ... kg.wt.

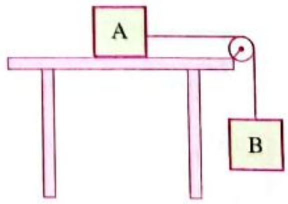


(a) 45 (b) $45\sqrt{3}$

(c) $30\sqrt{3}$ (d) $15\sqrt{3}$

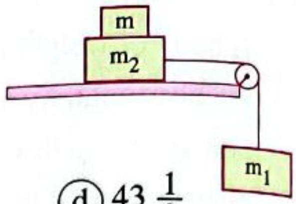
14 **In the opposite figure :**

If the pulley is small and smooth and the horizontal plane is rough. The coefficient of friction between A and the plane = 0.2. , the mass of A is 10 kg. , then the value for the mass of B to make the system about to move equals .... kg.



(a) 2 (b) 2.2 (c) 4.8 (d) 0.2

15 **In the opposite figure :**

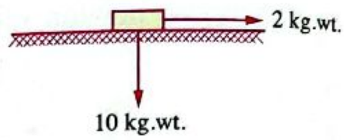


If $m_1 = 5$ kg. , $m_2 = 10$ kg. The coefficient of friction between m_2 and the horizontal plane $= 0.15$, then the least mass m should be placed up on m_2 to keep the system in equilibrium equals .... kg.

(a) $18\frac{1}{3}$ (b) $23\frac{1}{3}$ (c) $10\frac{1}{3}$ (d) $43\frac{1}{3}$

---

16 A body of weight 10 kg.wt. placed on a rough horizontal plane , if the coefficient of static friction between them is $\frac{1}{4}$ and a horizontal force of magnitude 2 kg.wt. acts upon the body , friction force symboled by F kg.wt. , then ....

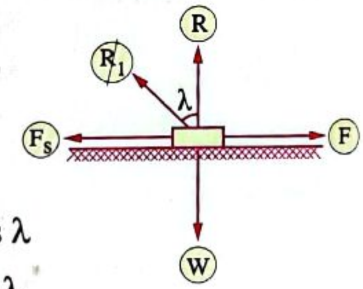


(a) $F < 2$ (b) $F = 2$

(c) $2 < F < 2.5$ (d) $F = 2.5$

---

17 **In the opposite figure :**



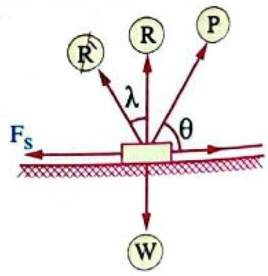
If the friction is limiting and the coefficient of static friction between the body and the plane is μ_s , then all the following statements are true except ....

(a) $\grave{R} = \sqrt{1 + \mu_s^2}$ (b) $W = \grave{R} \cos \lambda$

(c) $\mu_s R = \grave{R} \sin \lambda$ (d) $R = \grave{R} \cos \lambda$

---

18 **In the opposite figure :**

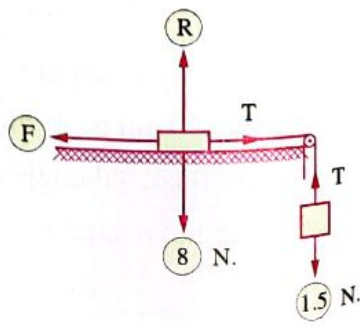


If a body is in equilibrium on a rough horizontal plane A force $\vec{P}$ inclined to the horizontal at an angle of measure θ. The friction is limiting at $\theta = 60°$ and $\lambda = 30°$, then all the following statements are true except ....

(a) $F_s = \frac{1}{2} P$ (b) $\grave{R} = P$ (c) $R = \frac{\sqrt{3}}{3} P$ (d) $W = \sqrt{3} P$

---

19 **In the opposite figure :**



The coefficient of static friction equals $\frac{1}{4}$, then ....

(a) the friction = 2 newton.

(b) the body moves on the plane.

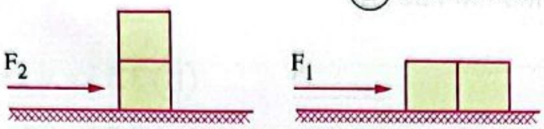
(c) the friction between the body and the plane is limiting.

(d) the friction between the body and the plane is not limiting.

20 The following two shapes show two bricks of the same material equal in mass and volume , placed on a horizontal rough plane in two different positions force F acts on them to make them about to move , then ....

(a) $F_1 < F_2$ (b) $F_1 > F_2$

(c) $F_1 = F_2$ (d) can not compare between them.



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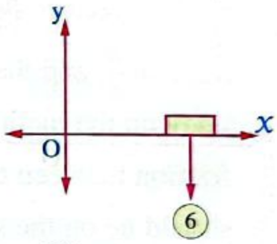
21 **In the opposite figure :**

A body of weight 6 N is placed on a rough horizontal plane the coefficient of static friction between the body and the plane $= \frac{1}{2\sqrt{3}}$. Force $\vec{F} = 5\sqrt{3}\,\hat{i} - a\,\hat{j}$ acts on the body and makes the body about to move then a = ...

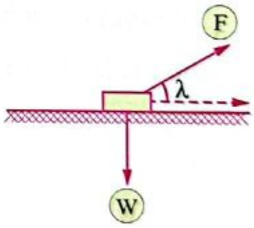


(a) 12 (b) 18 (c) 24 (d) 36

---

22 **In the opposite figure :**

A body of weight (W) newton is placed on a rough horizontal plane. The coefficient of static friction between the body and the plane = tan λ. Force of magnitude (F) N. acts on the body and inclined with the horizontal at an angle of measure (λ) and makes the body about to move , then each of the following is true except ....

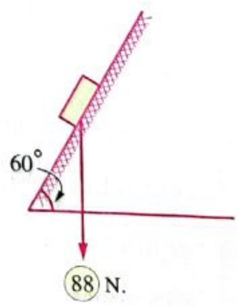


(a) $\vec{F} \perp \vec{R}$ (b) $F = \grave{R} \tan \lambda$ (c) $F = R \tan \lambda$ (d) $F = W \sin \lambda$

---

23 ***(Trial 2021)*** **In the opposite figure :**

A body of weight 88 newtons placed on a rough inclined plane makes with the horizontal an angle of measure 60°. If the body about to slide , then the magnitude of the limiting static friction = ... newtons

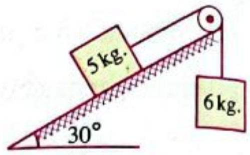


(a) $22\sqrt{3}$ (b) $44\sqrt{3}$

(c) 22 (d) 44

24 **In the opposite figure :**

A body of mass 5 kg. is placed on a rough inclined plane, connected with light string passes over a smooth pulley at the edge of the plane and the other end of the string tied to a body of mass 6 kg. If the system is in equilibrium , then the magnitude and the direction of the friction force is ....

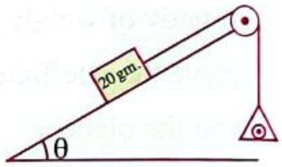


(a) 3.5 kg.wt. upward.
(b) 3.5 kg.wt. downward.
(c) 8.5 kg.wt. upward.
(d) 8.5 kg.wt. downward.

---

25 **In the opposite figure :**

$\tan\theta = \frac{4}{3}$ and the scale pan mass is 7 gm. and the mass of the body on the inclined plane = 20 gm. The coefficient of static friction between the body and the plane equals $\frac{1}{6}$, then the mass should be on the scale pan to vanish the friction force = ... gm.

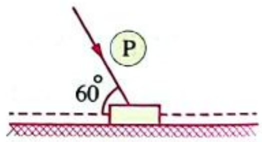


(a) 9
(b) 10
(c) 11
(d) 12

---

26 **In the opposite figure :**

The mass of a body placed on a horizontal plane is $10\sqrt{3}$ kg. and the coefficient of static friction between the body and the plane is $\frac{1}{2\sqrt{3}}$, then the greatest force P can act on the body and keeps it in equilibrium .... kg.wt.

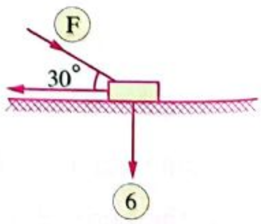


(a) 20
(b) 15
(c) 10
(d) 5

---

27 *(Trial 2021)* **In the opposite figure :**

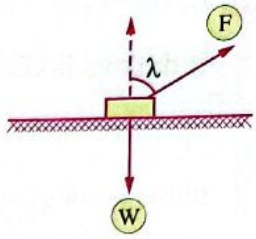
A body of weight 6 N. is placed on a rough horizontal plane.
A force of magnitude 6 N. acts on the body and acts in direction inclined with the horizontal at an angle of measure 30°
The body becomes about to move , then the measure of the angle between the resultant reaction ($\grave{R}$) and the force (F) equals ....



(a) 30°
(b) 60°
(c) 130°
(d) 150°

28 In the opposite figure :

A body of weight (W) kg.wt. is placed on a rough horizontal plane.
Force of magnitude F kg.wt. inclined with the vertical at an angle of measure λ and makes the body about to move where λ is the angle of friction. If F = W , then λ = ...°

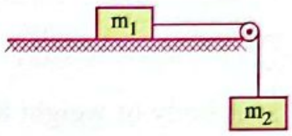


ⓐ 15 ⓑ 20 ⓒ 30 ⓓ 60

---

29 *(Trial 2021)* **In the opposite figure :**

If the system is about to move when tangent of the angle between the normal reaction and the resultant reaction = 0.2 , then the ratio $m_1 : m_2$ = ...

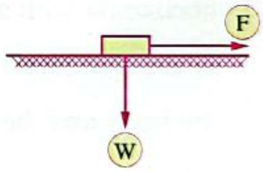


ⓐ 1 : 5 ⓑ 2 : 3 ⓒ 3 : 2 ⓓ 5 : 1

---

30 *(1^{st} Session 2021)* **In the opposite figure :**

A body of weight (W) newton placed on a rough horizontal plane. A horizontal force of magnitude F newton acts on the body trying to move it. If the resultant reaction in newton $\in]6 , 12]$, then the measure of the angle of friction is ....°

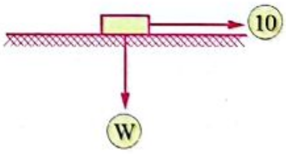


ⓐ 15 ⓑ 30 ⓒ 60 ⓓ 45

---

31 In the opposite figure :

A body of weight (W) kg.wt. is placed on a rough horizontal surface. A horizontal force of magnitude 10 kg.wt. acts on the body and makes the body about to move.
The resultant reaction of the surface is $10\sqrt{2}$ kg.wt.
, then the weight of the body (W) = ... kg.wt.

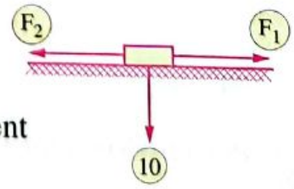


ⓐ 10 ⓑ 20 ⓒ $10\sqrt{2}$ ⓓ $20\sqrt{2}$

---

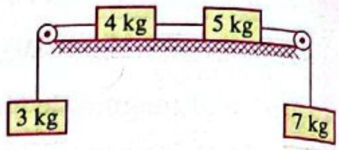
32 In the opposite figure :

A body of weight 10 kg.wt. is placed on a rough horizontal palne. Two forces F_1 and F_2 of magnitude 12 , 17 kg.wt. respectively act on the body to make it about to move. If the coefficient of friction between the body and the plane $\mu_S = \sqrt{3}$
, then the resultant reaction = ... kg.wt.



ⓐ $5\sqrt{5}$ ⓑ $10\sqrt{5}$ ⓒ 10 ⓓ 20

33 **In the opposite figure :**

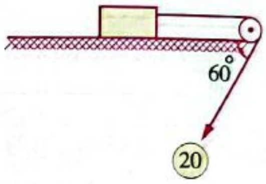


If the two bodies of masses 5 kg. and 4 kg. are made from the same material and the plane is rough and the system is about to move , then the coefficient of static friction = ...

(a) $\frac{7}{9}$ (b) $\frac{4}{9}$ (c) $\frac{5}{7}$ (d) $\frac{3}{4}$

---

34 ***(2nd Session 2021)*** **In the opposite figure :**

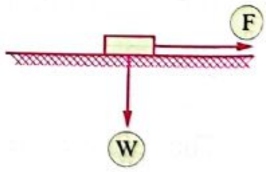


A body of weight 80 newton is placed on a horizontal rough plane , the body is tied to the end of a light inelastic string passes over a small smooth pulley and the other end of the string is tensioned by a force of magnitude 20 newton inclined to the horizontal with angle of measure 60° downward , if the body is about to move , then the coefficient of static friction between the body and the plane = ...

(a) $\frac{1}{8}$ (b) $\frac{1}{4}$ (c) $\frac{\sqrt{3}}{8}$ (d) $\frac{1}{2}$

---

35 ***(2nd Session 2021)*** **In the opposite figure :**

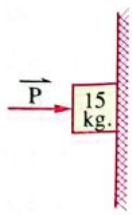


A horizontal force $\vec{F}$ (where F measured by newton) acts on a body of weight (W) newton placed on a rough horizontal plane , if the measure of the angle between the weight $\vec{W}$ and the resultant reaction $\vec{R}$ is θ , then the resultant reaction $\grave{R}$ = ... newton.

(a) – W sin θ (b) – W sec θ (c) W cos θ (d) W csc θ

---

36 **In the opposite figure :**



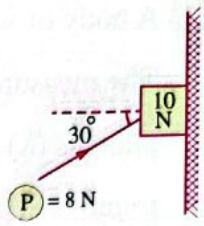
The least horizontal force $\vec{P}$ required to keep a body of mass 15 kg. in equilibrium on a rough vertical wall if the coefficient of static friction between the body and the wall equals $\frac{1}{5}$ is .... kg.wt.

(a) 5 (b) 25 (c) 3 (d) 75

37 **In the opposite figure :**

Force $\vec{P}$ of magnitude 8 N. makes an angle of measure 30° to the horizontal acts on a body of weight 10 N. placed on a vertical rough wall.

The body is about to move , then the coefficient of static friction between the body and the wall = ...

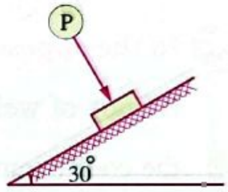


(a) $\frac{\sqrt{3}}{2}$ (b) $\frac{2}{\sqrt{3}}$ (c) $\sqrt{3}$ (d) $\frac{1}{\sqrt{3}}$

---

38 **In the opposite figure :**

A body of weight 12 kg.wt. is placed on a rough inclined plane makes with the horizontal an angle of measure 30°. The coefficient of static friction between the body and the plane is $\frac{\sqrt{3}}{9}$, then the least force perpendicular to the plane acting on the body can keep the body in equilibrium = ... kg.wt.



(a) $4\sqrt{3}$ (b) $9\sqrt{3}$ (c) $12\sqrt{3}$ (d) $18\sqrt{3}$

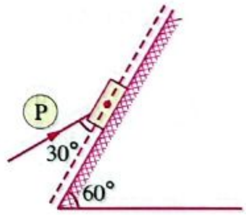
---

39 **In the opposite figure :**

A body of mass 10 kg. is placed on a rough inclined plane.

It makes an angle of measure 60° to the horizontal.

The coefficient of static friction between them is $\frac{1}{2}$. If the body is kept in equilibrium by a force P = 10 kg.wt. as shown in the figure , then the frictional force in this case equals ....



(a) zero (b) 5 kg.wt. up the plane.

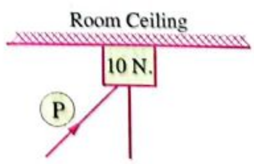
(c) 5 kg.wt. down the plane. (d) $5\sqrt{3}$ down the plane.

---

40 **In the opposite figure :**

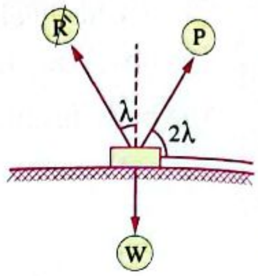
The weight of the body is 10 N. If P makes an angle 30° to the vertical and it makes the body about to move on the ceiling of the room and the coefficient of static friction between the body and the ceiling = $\frac{\sqrt{3}}{2}$

, then P = ... newtons.



(a) $10\sqrt{3}$ (b) $15\sqrt{3}$ (c) $20\sqrt{3}$ (d) $30\sqrt{2}$

41 A body of weight W is placed on a rough horizontal plane. The measure of angle of friction between the body and the plane is (λ). The force P acts on the body and makes it tends to move. The force P inclined to the horizontal at an angle (2λ) , then P = ...



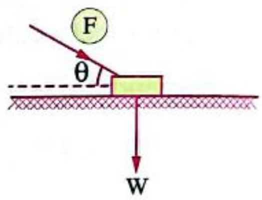
(a) W tan λ (b) W sin λ

(c) 2 W sin λ (d) W cot λ

---

42 **In the opposite figure :**

A body of weight (W) is placed on a rough horizontal plane , the coefficient of static friction between the body and the plane is μ_s. Force $\vec{F}$ acts on the body at an angle of measure θ above the horizontal. If the body becomes about to move when F = W then μ_s = ...



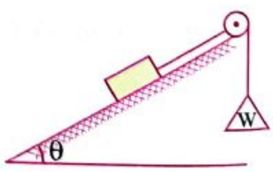
(a) $\cos\theta$ (b) $\frac{\cos\theta}{1+\sin\theta}$

(c) $\tan\theta$ (d) $\frac{\sin\theta}{1+\cos\theta}$

---

43 **In the opposite figure :**

A body of weight 15 N. is placed on a rough inclined plane makes an angle its tangent is $\frac{3}{4}$ with the horizontal and the coefficient of static friction between the body and the plane is $\frac{1}{3}$ This body is connected to another one hangs vertically and has weight (W) newton by a light string passes over a smooth small pulley fixed at the top of the inclined plane. If the system is in equilibrium then W $\in$ ....

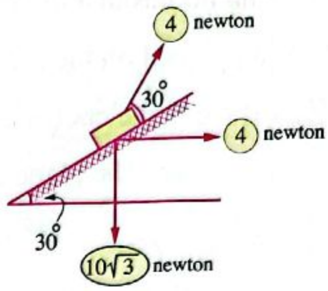


(a) [4 , 9] (b) [5 , 8]

(c) [5 , 13] (d) [4 , 8]

44 **In the opposite figure :**

A body has weight $10\sqrt{3}$ N. is placed on a rough inclined plane makes an angle of measure 30° above the horizontal. Two forces , magnitude of each is 4 N. , acts on it one of them acts horizontally and the other acts at an angle of measure 30° above the plane. If the body is about to slide , then the coefficient of friction is ....

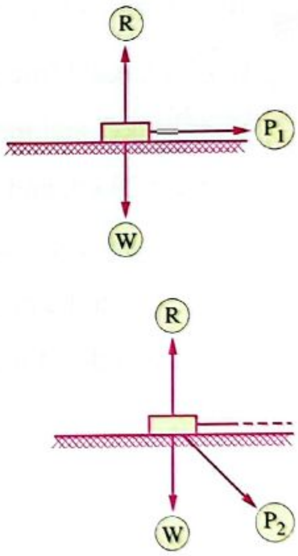


(a) $\frac{\sqrt{3}}{3}$ (b) $\frac{\sqrt{3}}{9}$ (c) $\frac{\sqrt{3}}{12}$ (d) $\frac{\sqrt{3}}{15}$

---

45 **In the opposite figure :**

A body of weight (W) is placed on a rough horizontal plane. The coefficient of friction between the body and the plane = tan λ. The sufficient horizontal force that makes the body about to move is P_1 and the sufficient inclined force which makes the body about to move makes an angle of measure (λ) below the horizontal is P_2 then $P_1 : P_2 =$ ....



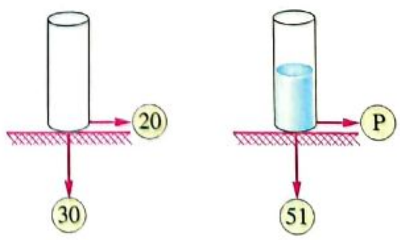
(a) cos λ : cos 2 λ (b) tan λ : tan 2 λ

(c) sec λ : sec 2 λ (d) cot λ : cot 2 λ

---

46 **In the opposite figure :**

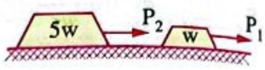
An empty container of weight 30 N. is placed on a rough horizontal plane. The horizontal force that makes the container about to move is 20 N. liquid is poured into the container till its weight becomes 51N. , then the horizontal force P can make it about to move = ... N.



(a) 20 (b) 34 (c) 41 (d) 76.5

47 In the opposite figure :

Two bodies of weights W , 5 W are made of the same material and placed on the same rough horizontal plane.



First : If the coefficient of static friction between the bodies and the plane are μ_1 , μ_2 respectively , then ....

(a) $\mu_1 = \mu_2$ (b) $\mu_2 = 5\,\mu_1$ (c) $\mu_2 = \frac{1}{5}\,\mu_1$ (d) $\mu_1 + \mu_2 = 1$

Second : If the limiting friction of the two bodies and the plane are F_1 , F_2 respectively , then ....

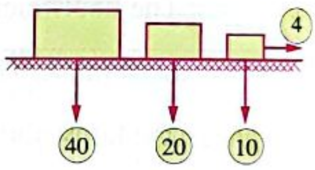
(a) $F_1 = F_2$ (b) $F_2 = 5\,F_1$

(c) $F_2 = \frac{1}{5}\,F_1$ (d) $F_1 + F_2 = 6\,W$

---

48 In the opposite figure :

If a horizontal force of magnitude 4 kg.wt. acts on a body of mass 10 kg. and makes it about to move , then two other bodies of mass 20 kg. and 40 kg. are made from the same material as the first one are connected to the first body with a light unexpandable string , then the magnitude of the horizontal force P that acts on the 3 bodies together and makes them about to move equals .... kg.wt.

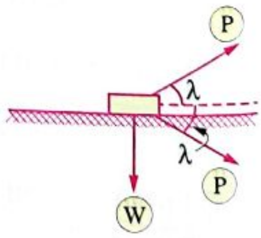


(a) 28 (b) 35 (c) 50 (d) 70

---

49 In the opposite figure :

A body of weight (W) kg.wt. is placed on a rough horizontal plane. Two forces , magnitude of each is P kg.wt. , act on the body and each makes with the horizontal an angle of measure λ , as shown in the figure , where λ is the measure of angle of friction. If the body is about to move , then P = ...

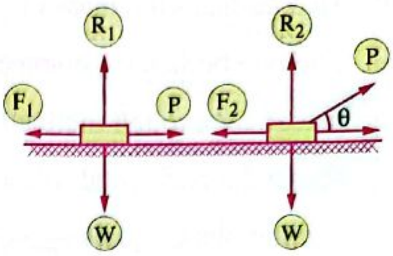


(a) $\frac{1}{2}$ W tan λ sec λ (b) 2 W tan λ sec λ

(c) $\frac{1}{2}$ W sin λ (d) 2 W sin λ

50 **In the opposite figure :**

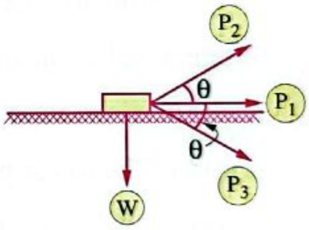
Two bodies made from the same material and weight of each is (W). They are placed on a rough horizontal plane. A horizontal force of magnitude P acts on one of them and an inclined force of magnitude P acts on the other. The inclined force makes with the horizontal an angle of measure θ. If F_1 and F_2 are the friction force in the two cases , then ....



(a) $F_1 < F_2 , R_1 < R_2$
(b) $F_1 > F_2 , R_1 > R_2$
(c) $F_1 > F_2 , R_1 < R_2$
(d) $F_1 = F_2 , R_1 = R_2$

51 **In the opposite figure :**

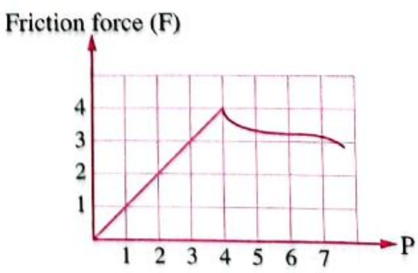
A body of weight (W) is placed on a rough horizontal plane. The coefficient of static friction between the body and the plane is μ_S. A horizontal force of magnitude P_1 and a force P_2 inclined to the horizontal at an angle of measure θ upward and a force P_3 inclined to the horizontal at an angle of measure θ downward act on the body individually and each makes the body about to move , then ....



(a) $P_1 = P_2 = P_3$
(b) $P_1 > P_2 > P_3$
(c) $P_2 < P_1 < P_3$
(d) $P_1 < P_2 , P_2 = P_3$

52 **The opposite figure :**

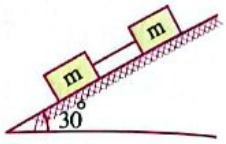
Represents the relation between the friction force (F) and the tangential force parallel to the plane (P) which acting on a body of weight $4\sqrt{3}$ kg.wt. placed on a horizontal rough plane. If the body is about to move , then the magnitude of the resultant reaction = ... kg.wt.



(a) 6
(b) $4\sqrt{3}$
(c) 8
(d) $8\sqrt{3}$

53 **In the opposite figure :**

Two bodies , the mass of each is m are made from the same material. The two bodies are connected by a light string. The two bodies are placed on a rough inclined plane makes an angle of measure 30° above the horizontal. If the coefficient of friction between each body and the plane equals $\frac{1}{\sqrt{3}}$, then ....



(a) The tension in the string > zero and the two bodies are about to move.

(b) The tension in the string > zero , but the two bodies are not about to move.

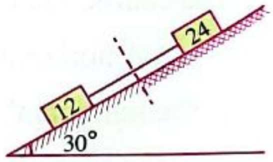
(c) The tension in the string = zero and the two bodies are about to move.

(d) The tension in the string = zero and the two bodies are not about to move.

---

54 **In the opposite figure :**

A plane makes an angle of measure 30° above the horizontal. Its upper portion is rough. A body of weight 24 N. is placed on this portion. The lower portion is smooth and a body of weight 12 N is placed on this portion. The two bodies are connected with a light string and the system is about to move , then the coefficient of static friction between the rough plane and the body on it = ...

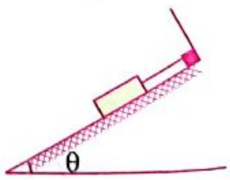


(a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{3}}$ (c) $\frac{\sqrt{3}}{2}$ (d) $\frac{2}{\sqrt{3}}$

---

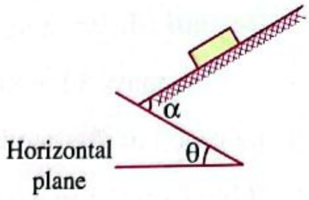
55 **In the opposite figure :**

If a body of weight 5 kg.wt. is placed on a rough plane inclined to the horizontal at an angle of measure θ where $\sin\theta = \frac{3}{5}$ It is tied to one end of a light inextensible string and the other end of the string is tied to a perpendicular barrier to the plane such that the string is parallel to the line of greatest slope of the plane. If the coefficient of static friction between the body and the plane is 0.8 , then the tension in the string = ... kg.wt



(a) zero (b) 3 (c) 3.2 (d) 4

56 **In the opposite figure :**



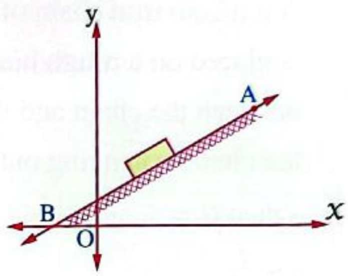
If the body tends to slide then the coefficient of friction between the body and the plane equals ....

(a) $\tan\theta$ (b) $\tan\alpha$

(c) $\tan(\alpha+\theta)$ (d) $\tan(\alpha-\theta)$

---

57 **In the opposite figure :**



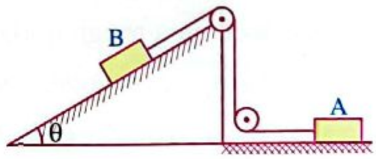
A body of weight 6 N is placed on a rough inclined plane $\overleftrightarrow{AB}$. The equation of the line of the greatest slope $\overleftrightarrow{AB}$ is $\sqrt{3}\,x - y + 3 = 0$. If the body tends to move downwards , then the limiting friction = ... N.

(a) $2\sqrt{3}$ (b) $3\sqrt{3}$

(c) 6 (d) 12

---

58 **In the opposite figure :**

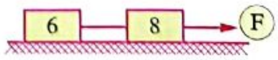


Two bodies A and B have the same weight , the first is placed on a rough horizontal plane , the coefficient of friction between the body and the plane is $\frac{1}{2}$. The second body is placed on a smooth inclined plane. The two bodies are connected by a light string passes over a smooth pullies. If the system tends to move , then the inclined plane makes with the horizontal plane an angle of measure ....

(a) 30° (b) 45° (c) 60° (d) 63°

---

59 **In the opposite figure :**



Two bodies of mass 8 kg and 6 kg. The two bodies are connected by a light string. The two bodies are placed on a rough horizontal plane and the coefficient of frictions between the two bodies and the plane are $\frac{1}{4}$, $\frac{1}{2}$ respectively :

First : If F = 2 kg.wt. then the tension in the string equals .... kg.wt.

(a) zero (b) 1 (c) 2 (d) 3

Second : If F = 3 kg.wt. then .... tends to move.

(a) the mass 8 kg only (b) the mass 6 kg only

(c) each of the two bodies (d) neither of the two bodies

Third : If the two bodies tend to move then F = ... kg.wt.

(a) 2 (b) 3 (c) 4 (d) 5

---

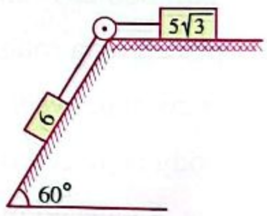
60 **In the opposite figure :**

A uniform iron chain of length (ℓ) cm. and weight (W) newton is placed on a rough horizontal table. The coefficient of friction between the chain and the table is (μ). A part of length (ℓ_1) cm. of the chain is hanging out of the table and the chain is about to move , then μ = ...

(a) $\frac{\ell_1}{\ell}$ (b) $\frac{\ell_1}{\ell - \ell_1}$ (c) $\frac{\ell}{\ell_1}$ (d) $\frac{\ell - \ell_1}{\ell_1}$

---

61 **In the opposite figure :**

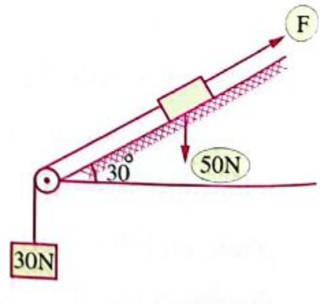


A body of weight 6 N is placed on a smooth inclined plane makes an angle of measure 60° with the horizontal. A body of weight $5\sqrt{3}$ N is placed on a rough horizontal plane. The two bodies are connected by a string passes over a smooth pulley and they were about to move then the coefficient of static friction between the body $5\sqrt{3}$ N and the rough plane equals ....

(a) $\frac{1}{2}$ (b) $\frac{5}{6}\sqrt{3}$ (c) $\frac{3}{5}$ (d) $\frac{5}{3}$

---

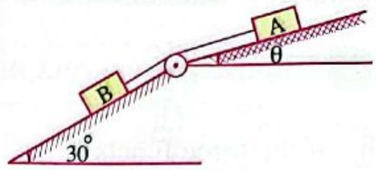
62 **In the opposite figure :**



A body has weight 50 N. The body is placed on a rough inclined plane makes an angle of measure 30° above the horizontal. The coefficient of static friction between the body and the plane is $\frac{1}{5\sqrt{3}}$ The body is connected to another one hangs vertically and has weight 30 N. by a light string which passes over a small smooth pulley a force $\vec{F}$ in direction of greatest slope upward acted on the body 50 N. If the system is in equilibrium then F $\in$ ....

(a) [45 , 65] (b) [50 , 60] (c) {55} (d) [75 , 85]

63 In the opposite figure :



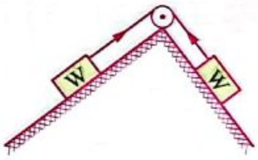
Two inclined planes , the first is smooth and inclined to the horizontal at an angle of measure 30°. The second is rough and inclined to the horizontal at an angle of measure θ where $\sin\theta = \frac{5}{13}$

Two bodies A and B of masses 39 kg. , 10 kg. are placed on the rough plane and the smooth plane respectively. The two bodies are connected by a light inextensible string passes over a smooth pulley fixed at the point of contact of the two planes. If the system is about to move , then the coefficient of friction between the body A and the plane = ...

(a) $\frac{\sqrt{5}}{3}$ (b) $\frac{3}{4}$ (c) 1 (d) $\frac{5}{9}$

---

64 Two inclined planes having the same height 60 cm. and the length of one of them = 75 cm. and the length of the other is 100 cm. Two equal bodies in mass and of the same material is placed on the two planes (one body for each) the two bodies are connected together by a string passing over a smooth pulley fixed at the top of the two planes. If the two planes have the same rough coefficient of friction and the group of two bodies are about to move, then the coefficient of static friction = ...

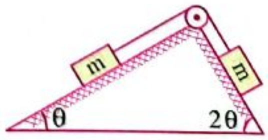


(a) $\frac{4}{5}$ (b) $\frac{1}{7}$ (c) $\frac{3}{5}$ (d) $\frac{3}{7}$

---

65 In the opposite figure :

Two bodies the mass of each is m kg. made from the same material are connected together by a light string passing over a smooth pully placed on two inclined plane and have the same roughness. If the system is about to move , then the coefficient of static friction = ...



(a) $\frac{\sin\theta}{1+\cos 2\theta}$ (b) $\frac{\sin\theta}{1-\cos\theta}$ (c) $\frac{\sin\theta}{1+\cos\theta}$ (d) $\frac{\cos\theta}{1+\cos\theta}$

Second Questions on moments

1 Choose the correct answer from those given :

1. If the force $\vec{F}$ acts at the point (A) , $\vec{M_O}$ is the moment of $\vec{F}$ about the origin O , then ....

ⓐ $\vec{M_O} = \overrightarrow{OA} \times \vec{F}$
ⓑ $\vec{M_O} = \overrightarrow{OA} \cdot \vec{F}$
ⓒ $\vec{M_O} = \vec{F} \cdot \overrightarrow{OA}$
ⓓ $\vec{M_O} = \vec{F} \times \overrightarrow{OA}$

2. If the force $\vec{F}$ acts at the point (A) , $\vec{M_O}$ is the moment of $\vec{F}$ about the point (O) , then the length of the perpendicular drawn from (O) to the line of action of $\vec{F}$ = ...

ⓐ $\|\vec{F}\|$
ⓑ $\|\vec{M_O}\| \times \|\vec{F}\|$
ⓒ $\frac{\|\vec{M_O}\|}{\|\vec{F}\|}$
ⓓ $\|\overrightarrow{OA} \times \vec{F}\|$

3. If $\vec{F} = 2\hat{i} - 3\hat{j}$, A (2 , 1) $\in$ the line of action of $\vec{F}$, O is the origin , then $\vec{M_O}$ = ... $\hat{k}$

ⓐ -8
ⓑ 8
ⓒ 1
ⓓ 7

4. If force $\vec{F} = 2\hat{i} + 5\hat{j}$ acts at the point A = (– 3 , 1) , then the moment of $\vec{F}$ about the point N (2 , – 4) equals ....

ⓐ $15\hat{k}$
ⓑ $35\hat{k}$
ⓒ $-\hat{k}$
ⓓ $-35\hat{k}$

5. Force $\vec{F} = 2\hat{i} + 5\hat{j}$ acts at the point A = (– 3 , 1) , then if N = (2 , – 4) , then $\vec{M_O} - \vec{M_N}$ = ...

ⓐ $-17\hat{k}$
ⓑ $-35\hat{k}$
ⓒ $-52\hat{k}$
ⓓ $18\hat{k}$

6. The moment of force $\vec{F}$ about the point (O) ....

ⓐ is constant , it does not depend on the point of action of the force on the line of action of $\vec{F}$
ⓑ varies according to the position of point of action of the force on the line of action of $\vec{F}$
ⓒ is positive if $\vec{F}$ rotates about (O) clockwise
ⓓ is negative if $\vec{F}$ rotates about (O) anti clockwise

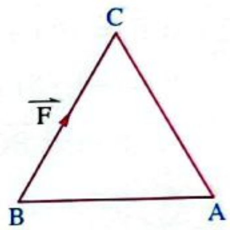
7. $\overrightarrow{F_1}$, $\overrightarrow{F_2}$, $\overrightarrow{F_3}$ are three forces act at (2 , 3) , if $\overrightarrow{F_1} = 2\hat{i} + 4\hat{j}$, $\overrightarrow{F_2} = \hat{i} - 2\hat{j}$, $\overrightarrow{F_3} = -3\hat{i} + 4\hat{j}$, then the sum of the moments of these forces about origin equals ....

(a) $6\hat{k}$ (b) $12\hat{k}$ (c) $-6\hat{k}$ (d) $-12\hat{k}$

8. If $\vec{F} = 20\hat{i} + 30\hat{j}$ acts at the point A (1 , 1) , then the moment of the force $\vec{F}$ about the point B (4 , 0) = ... $\hat{k}$

(a) -110 (b) 110 (c) 70 (d) -90

9. **In the opposite figure :**



If the force $\vec{F}$ is represented by $\overline{BC}$ where the length unit represents a force unit then $\|\overrightarrow{M_A}\| =$ ....

(a) $\|\overrightarrow{AC}\| \times \|\vec{F}\|$ (b) $\|\overrightarrow{AB}\| \times \|\vec{F}\|$

(c) $\frac{1}{2}$ the area of Δ ABC (d) 2 the area of Δ ABC

10. If $\vec{F} = 7\hat{j}$ acts at the point (– 3 , 0) , then the moment of the force $\vec{F}$ about the point (1 , – 2) is ....

(a) $-28\hat{k}$ (b) $28\hat{k}$ (c) $14\hat{k}$ (d) $-14\hat{k}$

11. If $\vec{F} = 6\hat{i} - 8\hat{j}$ acts at the point A (3 , – 2) , then the length of the perpendicular drawn from the point B (2 , 4) to the line of action of the force $\vec{F}$ = ... length unit.

(a) 5.4 (b) 2.8 (c) 28 (d) 4.4

12. If the line of action of force $\vec{F} \parallel \overline{AB}$, $C \in \overleftrightarrow{AB}$, if $\overrightarrow{M_A} + \overrightarrow{M_B} = 12\vec{k}$, then $\overrightarrow{M_C} =$ .... $\vec{k}$

(a) 12 (b) – 6 (c) 6 (d) 4

13. If the sum of the moments of some forces about A = the sum of the moments of these forces about B , then the line of action of their resultant ....

(a) is perpendicular to $\overline{AB}$ (b) is parallel to $\overline{AB}$

(c) bisects $\overline{AB}$ (d) coincide with $\overline{AB}$

14 If the sum of the moments of force $\vec{F}$ about two points A , B vanished , then the line of action of $\vec{F}$ ....

(a) is parallel to $\overline{AB}$
(b) is perpendicular to $\overline{AB}$
(c) passes through A or B
(d) bisects $\overline{AB}$

15 If $\vec{F} = 7\hat{i} - 3\hat{j}$, the two points A , B lie in the plane of $\vec{F}$, $M_A = M_B$, then the slope of $\overleftrightarrow{AB} =$ ....

(a) $\frac{7}{3}$
(b) $\frac{-7}{3}$
(c) $\frac{-3}{7}$
(d) $\frac{3}{7}$

16 If $\vec{F_1} = 10\hat{i} + 20\hat{j}$, $\vec{F_2} = -10\hat{i} + 30\hat{j}$. They are acting at the point $A = (-2 , 3)$ and if $B = (-1 , 5)$, $C = (-3 , 2)$, then the line of action of resultant of $\vec{F_1}$ and $\vec{F_2}$ ....

(a) bisects $\overline{BC}$
(b) is parallel to $\overline{BC}$
(c) passes through the point B
(d) passes through the point C

17 The moment of force $\vec{F}$ about point A equals M_1. If the force has moved parallel to itself towards A its moment about A becomes M_2 then ....

(a) $M_2 > M_1$
(b) $M_2 < M_1$
(c) $M_2 = M_1$
(d) $M_2 + M_1 =$ zero

18 If A , B , C are three points in the plane of force $\vec{F}$ where B is the midpoint of $\overline{AC}$ and $\overline{M_A} = 3$ moment units , $\overline{M_C} = 9$ moment units , then $M_B =$ .... moment units.

(a) 4
(b) 5
(c) 6
(d) 12

19 If A , B , C are three points in the same plane as force $\vec{F}$ and $M_A = M_B = M_C$, then ....

(a) AB = BC
(b) ABC is a right-angled triangle.
(c) A , B , C are collinear.
(d) B is the midpoint of $\overline{AC}$

20 If the force $\vec{F} = (\ell , m)$ acts at the point A (4 , 8) and the moment of $\vec{F}$ about B (3 , 9) equals $40\hat{k}$, then $\ell + m =$ ....

(a) 40
(b) 20
(c) 10
(d) 80

21 If the force $\vec{F} = (m , 7)$ acts at the point A (1 , m) and its moment vector about B (0 , 1) equals $5\hat{k}$, then m ∈ ....

ⓐ $\{-2 , 1\}$ ⓑ $\{-2 , -1\}$ ⓒ $\{2 , -1\}$ ⓓ $\{1 , 2\}$

22 If $\vec{F} = 5\hat{i} + 12\hat{j}$ and its line of action has the equation $-12x + 5y = \text{zero}$, then the moment of the force $\vec{F}$ about B (– 3 , 1) equals .... $\hat{k}$

ⓐ zero ⓑ – 11 ⓒ 31 ⓓ 41

23 If $\vec{F} = 5\hat{i} + 4\hat{j}$ and the two points A , B lie in the same plane as $\vec{F}$ where A (2 , 3) and $M_A = M_B$, then the equation of the straight line $\overleftrightarrow{AB}$ is ....

ⓐ $4x - 5y + 7 = 0$ ⓑ $5x - 4y + 7 = 0$

ⓒ $4x - 5y = 0$ ⓓ $5x + 4y + 7 = 0$

24 If the moment of the force $\vec{F} = 4\hat{i} + 6\hat{j}$ about the origin equals $80\hat{k}$, then the equation of the line of action of $\vec{F}$ is ....

ⓐ $2x + 3y = 40$ ⓑ $4x + 3y = 10$

ⓒ $3x - 2y = 40$ ⓓ $3x - 2y = 80$

25 If the moment of force $\vec{F} = 3\hat{i} - 4\hat{j}$ about point B (2 , – 1) is $-16\hat{k}$ then the line of action of $\vec{F}$ passes through the point ....

ⓐ (–3 , 11) ⓑ (2 , –5) ⓒ (1 , 0) ⓓ (–1 , –11)

26 If $F = 3\hat{i} + 4\hat{j}$, $\overrightarrow{M_O} = 16\hat{k}$ where O is the origin and B (–1 , 5) , then $\overrightarrow{M_B}$ = ...

ⓐ $16\hat{k}$ ⓑ $19\hat{k}$ ⓒ $35\hat{k}$ ⓓ $3\hat{k}$

27 The moment of force $\vec{F}$ about the point (3 , 5) is $6\hat{k}$ and its moment about the point (1 , – 1) is $-6\hat{k}$, then its moment about the point .... $= \vec{0}$

ⓐ (– 1 , – 3) ⓑ (2 , 2) ⓒ (2 , 6) ⓓ (1 , 3)

28 If the line of action of force $\vec{F}$ passes through point A (2 , 0) and parallel to the y-axis. $\overrightarrow{M_B} = -\overrightarrow{M_C}$ where B = (5 , 0) , then C could be any of the following except ....

ⓐ (–1 , 5) ⓑ (0 , –1) ⓒ (–1 , 0) ⓓ (–1 , 8)

29 If the line of action of force $\overrightarrow{F}$, where $\overrightarrow{F} = \hat{i} + \hat{j}$, bisects $\overline{AB}$ where A (3 , – 1) and D (1 , 4) is the midpoint of $\overline{AB}$, then $\overrightarrow{M_B}$ = ... $\hat{k}$

(a) – 7 (b) 7 (c) 3 (d) – 14

---

30 If $\overrightarrow{F} = 3\,i - 2\,j$, A (– 1 , 2) , the moment of $\overrightarrow{F}$ about A is $\overrightarrow{M_A} = 9\,\overrightarrow{k}$, the moment of $\overrightarrow{F}$ about B is $\overrightarrow{M_B} = 9\,\overrightarrow{k}$, then the coordinates of the point B can be represented by one of the following ordered pairs except ....

(a) (5 , – 2) (b) (2 , 0) (c) (– 8 , 4) (d) (8 , – 4)

---

31 The force $\overrightarrow{F}$ acts in the plane of the triangle ABC where A (3 , 2) , B (1 , – 4) , C (– 1 , 0) If $\overrightarrow{M_A} = \overrightarrow{M_B} = 60\,\hat{k}$ and $\overrightarrow{M_C} = -60\,\hat{k}$, then the norm of $\overrightarrow{F}$ equal ....

(a) $10\sqrt{3}$ (b) $12\sqrt{10}$ (c) $21\sqrt{10}$ (d) $21\sqrt{3}$

---

32 Force $\overrightarrow{F} = \ell\,\hat{i} + m\,\hat{j}$ acts at the point A (2 , – 1) , the moment of this force about the point B (ℓ , m) equals 10 $\hat{k}$ and its moment about the point C (– 1 , 3) equals 25 $\hat{k}$, then the length of the perpendicular drawn from B on the line of action of $\overrightarrow{F}$ equals .... length unit.

(a) 1 (b) 2 (c) 3 (d) 4

---

33 If $\overrightarrow{F} = \hat{i} + k\,\hat{j}$ acts at point A (2 , 3) and the length of the perpendicular drawn from B (2 , 1) to the line of action of force $\overrightarrow{F}$ equals $\frac{2\sqrt{5}}{5}$, then k = ...

(a) ± 1 (b) ± 2 (c) ± 3 (d) ± 4

---

34 Force $\overrightarrow{F}$ acts at point A (– 3 , 2). If the moment of $\overrightarrow{F}$ about each of the two points B (3 , 1) and C (–1 , 4) equals 28 $\hat{k}$, then $\overrightarrow{F}$ = ...

(a) $8\,\hat{i} + 6\,\hat{j}$ (b) $8\,\hat{i} - 6\,\hat{j}$ (c) $-8\,\hat{i} + 6\,\hat{j}$ (d) $-8\,\hat{i} - 6\,\hat{j}$

---

35 The algebraic measure of moment of a 10-newton force acts at $\overrightarrow{AB}$ where A (2 , 7) , B (5 , 3) about the origin equals .... moment unit.

(a) 58 (b) 68 (c) – 58 (d) – 68

36 If the force $\vec{F}$ acts in $\overrightarrow{AB}$ direction where A (3 , 0) , B (0 , – 4). If $\| \vec{F} \| = 15$ N. , then the length of the perpendicular drawn from the origin to the line of action of $\vec{F}$ equals .... length units.

(a) 2.4 (b) 2.8 (c) 4.2 (d) 3

---

37 ***(Trial 2021)*** Force $\vec{F} = 3\hat{i} + 2\hat{j}$ acts at a point. The moment of $\vec{F}$ about origin is $15\hat{k}$, then intersection point of the line of action of $\vec{F}$ with the y-axis is ....

(a) (0 , – 5) (b) (0 , 15) (c) (0 , 5) (d) (0 , – 15)

---

38 If $\vec{F} = 2\hat{i} + 3\hat{j}$ acts at point C and $\overrightarrow{AB} = 4\hat{i} + 6\hat{j}$ and $\overrightarrow{M_A} = (m^2 + 4)\hat{k}$, $\overrightarrow{M_B} = (4m)\hat{k}$, then m = ...

(a) 3 (b) 2 (c) 4 (d) 1

---

39 The force $\vec{F}$ acts at point A , the points A , B , C lies on the same plane as $\vec{F}$ and $\overrightarrow{M_B} = -12\hat{k}$, $\overrightarrow{BC} \times \vec{F} = 23\hat{k}$, then $\overrightarrow{M_C}$ = ...

(a) $-11\hat{k}$ (b) $11\hat{k}$ (c) $-35\hat{k}$ (d) $35\hat{k}$

---

40 If the force $\vec{F} = \left(10 , \frac{\pi}{3}\right)$ acts at the point A $\left(\sqrt{3} , 2\right)$, then the moment of the force $\vec{F}$ about the origin "O" equals ....

(a) $-5\hat{k}$ (b) $5\hat{k}$ (c) $5\sqrt{3}\hat{k}$ (d) $-25\hat{k}$

---

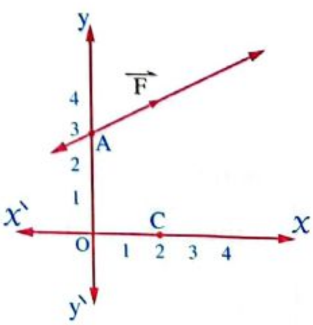
41 Force $\vec{F} = (-3\sin\theta)\hat{i} + (2\cos\theta)\hat{j}$ acts at point A $(3\cos\theta , 2\sin\theta)$ for any angle of measure θ , then the algebraic measure of the moment of force $\vec{F}$ about the origin equals .... moment units.

(a) zero (b) 3 (c) 4 (d) 6

---

42 **In the opposite figure :**

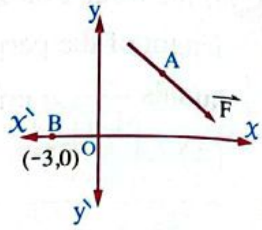
If the equation of the line of action of force $\vec{F}$ is $2x - y + 3 = 0$, $\| \vec{F} \| = 6\sqrt{5}$, then the algebraic measure of moment of $\vec{F}$ about C equals ....



(a) $-30\sqrt{5}$ (b) 35

(c) 42 (d) – 42

43 **In the opposite figure :**



If the point A lies on the line of action of force $\vec{F}$. The moment of the force $\vec{F} = 4\hat{i} - 3\hat{j}$ about origin equals $-200\hat{k}$, then moment of the force $\vec{F}$ about the point B $(-3, 0)$ equals ....

(a) $-200\hat{k}$ (b) $200\hat{k}$

(c) $-209\hat{k}$ (d) $-191\hat{k}$

---

44 If the algebraic measure of the moment of force $\vec{F}$ about each of the point O $(0, 0)$, D $(1, 0)$, E $(0, 2)$ equals 27 , 18 , $40\frac{1}{2}$ moment unit , then $\vec{F} =$ ....

(a) $27\vec{x} + 9\vec{y}$ (b) $\frac{27}{4}\vec{x} + 9\vec{y}$

(c) $27\vec{x} + \frac{9}{4}\vec{y}$ (d) $\frac{27}{4}\vec{x} + \frac{9}{4}\vec{y}$

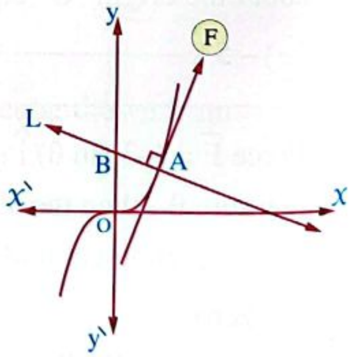
---

45 If the equation of the line of action of the force $\vec{F}$ is $\vec{r} = (2, 3) + k(4, 5)$, then the moment of the force $\vec{F}$ about the point A $(10, 13)$ is ....

(a) $\overrightarrow{\text{zero}}$ (b) $2\hat{k}$ (c) $-2\hat{k}$ (d) $-4\hat{k}$

---

46 **In the opposite figure :**



Force of magnitude $6\sqrt{10}$ N.acts parallel to the tangent to the curve $y = x^3$ at the point A $(1, 1)$ as shown in the figure. If the straight line L is perpendicular to the tangent at $(1, 1)$, then magnitude of the moment of $\vec{F}$ about B equals .... moment unit.

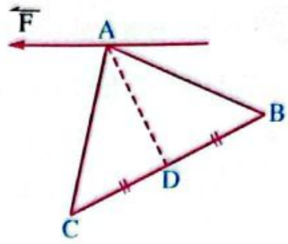
(a) 10 (b) 20 (c) $2\sqrt{10}$ (d) 180

---

47 Force $\vec{F} = 3\hat{i} - 4\hat{j}$ acts at the point $(0, 2)$ and $\overrightarrow{BC} = (-4, -2)$, the length of the perpendicular drawn from B to the line of action of $\vec{F}$ equals that drawn from C , then $\vec{M}_B + \vec{M}_C =$ ....

(a) $2\vec{M}_B$ (b) $\frac{1}{2}\vec{M}_B$ (c) $-2\vec{M}_C$ (d) $\overrightarrow{\text{zero}}$

48 **In the opposite figure :**



If force $\vec{F}$ acts in the plane of Δ ABC and $M_B = 8$ N.cm. , $M_C = 12$ N.cm. , then , $M_D =$ .... N.cm.

ⓐ 4 ⓑ 10 ⓒ 20 ⓓ 40

---

49 If A , B , C , D are points on the straight line L , force $\vec{F}$ acts such that $\vec{F}$ // the straight line L and $3\,M_A + 2\,M_B = 30$ N.cm. , then $3\,M_B - 2\,M_C + M_D =$ .... N.cm.

ⓐ 12 ⓑ 15 ⓒ 18 ⓓ 24

---

50 If F is a force in the plane of rectangle ABCD , M is the point of intersection of its diagonals and $M_A = -28$ N.m. , $M_M = 24$ N.m. , then $M_C =$ .... N.m.

ⓐ -4 ⓑ 10 ⓒ 20 ⓓ 76

---

51 If $\vec{F}$ is a force in the plane of parallelogram ABCD and $M_A = -18$ units of moment , $M_B = M_D = 32$ units of moment , then $M_C =$ .... unit of moment.

ⓐ 50 ⓑ 82 ⓒ 46 ⓓ 14

---

52 If F is a force acting in the plane of Δ ABC , D $\in \overline{BC}$ where $\frac{BD}{DC} = \frac{1}{5}$ and $M_B = 10$ N.cm. , $M_D = 6$ N.cm. , then $M_C =$ .... N.cm.

ⓐ 16 ⓑ 14 ⓒ -14 ⓓ -40

---

53 If force $\vec{F}$ acts in the plane of Δ ABC and $M_A = 2\,M_B$, D is the midpoint of $\overline{AB}$, then $M_B - M_A =$ .... M_D

ⓐ $-\frac{1}{2}$ ⓑ $\frac{-2}{3}$ ⓒ $\frac{4}{3}$ ⓓ 2

---

54 If A , B , C are three collinear points where AB : BC = 2 : 3 , the force $\vec{F}$ lies in the same plane as the 3 points where $M_A = 8$ moment units , $M_C = 5\frac{1}{2}$ moment units , then $M_B =$ .... moment units.

ⓐ 4 ⓑ 5 ⓒ 6 ⓓ 7

55 ABC is a right-angled triangle at B , $AB = 3$ cm. , $BC = 4$ cm. , $\vec{F}$ is a force acting in the plane of the triangle and parallel to $\overline{AC}$, if $F = 15$ N. , then $\| \overrightarrow{M_B} - \overrightarrow{M_A} \| =$ .... N.cm.

ⓐ 36 ⓑ 12 ⓒ 45 ⓓ 60

---

56 The diagonals of rectangle ABCD intersect at M , force $\vec{F}$ acts in its plane such that $M_A = - M_C$, then the line of action of $\vec{F}$ is ....

ⓐ parallel to $\overline{AC}$
ⓑ parallel to $\overline{BC}$
ⓒ passes through M
ⓓ passes through B

---

57 The diagonals of parallelogram ABCD intersect at M force $\vec{F}$ acts in its plane such that $M_A = M_B$, then ....

ⓐ the line of action $\vec{F}$ must pass through M
ⓑ $M_M = \frac{1}{2} (M_A + M_B)$
ⓒ $M_C - M_D =$ zero
ⓓ the line of action of $\vec{F}$ bisects $\overline{AB}$

---

58 ABC is a right-angled triangle at B , $AB = 3$ cm. , $BC = 8$ cm. Force $\vec{F}$ acts in the same plane as triangle ABC and $M_A =$ zero , $M_B = - M_C = 60$ N.cm.
, then $\| \vec{F} \| =$ .... N.

ⓐ 25 ⓑ 30 ⓒ 40 ⓓ 60

---

59 If A and B are two points in the same plane of force $\vec{F}$ such that $\overrightarrow{M_A} = - 8 \hat{e}$, $\overrightarrow{M_B} = 12 \hat{e}$, then the line of action of the force $\vec{F}$ intersects $\overleftrightarrow{AB}$ at C where ....

ⓐ AC : CB = 2 : 1
ⓑ AC : AB = 2 : 5
ⓒ AC : CB = 3 : 2
ⓓ AC : AB = 2 : 3

---

60 ABCDEF is a regular hexagon. Force $\vec{F}$ acts in its plane and $M_A = - 20$ N.cm.
, $M_D = 80$ N.cm. , then $M_A + M_B + M_D + M_E =$ .... N.cm.

ⓐ – 200 ⓑ 200 ⓒ 60 ⓓ 120

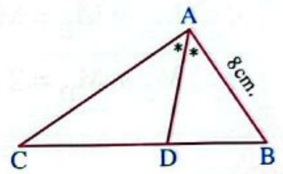
61 ABC is an equilateral triangle , its surface area = k square units. M is the point of intersection of its median. If $\vec{F}$ is represented completely by $\overrightarrow{CB}$ where each unit of force represents one unit of length , then the moment of the force of $\vec{F}$ about M equals ....

(a) $\frac{1}{2}$ k (b) $\frac{1}{3}$ k (c) $\frac{2}{3}$ k (d) k

62 ABCD is an isosceles trapezium. $\overline{AD} \parallel \overline{BC}$, AD = $\frac{1}{2}$ BC. The diagonals of the trapezium intersect at N. and the area of Δ AND = k square units and the force $\vec{F}$ represented completely by vector $\overrightarrow{BC}$ where each unit of force represents one unit of length , then the moment of the force $\vec{F}$ about A equals .... moment unit.

(a) 3 k (b) 6 k (c) 9 k (d) 12 k

63 **In the opposite figure :**



If $\overrightarrow{AD}$ bisects $\angle$ A. Force $\vec{F}$ acts in the plane of Δ ABC ,

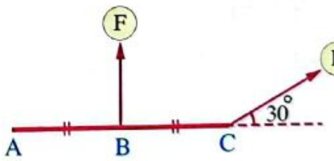
M_B = 5 moment unit , M_C = 10 moment unit ,

M_D = 7 moment unit.

AB = 8 cm. , then AC = ... cm.

(a) 9 (b) 10 (c) 12 (d) 16

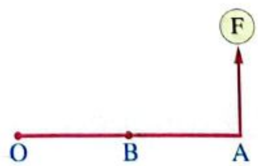
64 **In the opposite figure :**



If the algebraic measure of the moment of the force F which is perpendicular to the rod about A equals M_1 and the algebraic measure of the moment of the force F at C about A equals M_2 , then ....

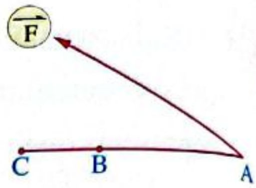
(a) $M_1 < M_2$ (b) $M_1 > M_2$
(c) $M_1 = M_2$ (d) $M_1 + M_2$ = zero

65 If the magnitude of the moment of F about O equals 60 and the magnitude of the moment of F about (B) equals 40 , then ....



(a) AB = BO (b) AB = $\frac{1}{2}$ BO
(c) AB = 2 BO (d) AB = $\frac{2}{3}$ BO

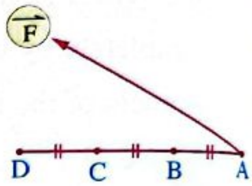
66 **In the opposite figure :**



If the magnitude of the moment of $\vec{F}$ about B equals M_B and the magnitude of moment of $\vec{F}$ about C equals M_C , then ....

(a) $M_B = M_C$ (b) $M_B + M_C = \text{zero}$ (c) $\frac{M_B}{M_C} = \frac{AB}{AC}$ (d) $\frac{M_B}{M_C} = \frac{AB}{BC}$

67 **In the opposite figure :**



If the the algebraic measure of the moments of $\vec{F}$ about each of B , C , D are M_B , M_C , M_D respectively.

Which of the following statements is not true ?

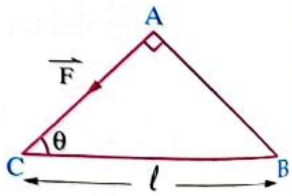
(a) $M_A = M_B = M_C$ (b) $M_B + M_C = M_D$

(c) $M_B + M_D = 2\,M_C$ (d) $M_B : M_C : M_D = 1 : 2 : 3$

68 The points A (2 , 7) , B (2 , 10) and C (x , y) are vertices of right-angled triangle at B , forces of magnitudes 15 , 14 , F kg.wt. act along $\overrightarrow{AB}$, $\overrightarrow{BC}$ and $\overrightarrow{CA}$ respectively , if the magnitude of the resultant of these forces is 6 kg.wt. and the resultant acts along the positive direction of x-axis , then magnitude of F = ...

(a) 20 (b) 25 (c) 30 (d) 35

69 **In the opposite figure :**



ABC is a right-angled triangle at ∠ A in which BC = ℓ (constant) , force $\vec{F}$ represented completely by $\overrightarrow{AC}$. If the length of each of $\overline{AB}$ and $\overline{AC}$ varies as θ , then the greatest moment of the force $\vec{F}$ about B occurs when θ = ...

(a) 90° (b) 60° (c) 45° (d) 30°

2 Choose the correct answer from the given ones :

1 A force of a magnitude 50 newtons and is 8 cm. away from point A , then the norm of the moment of the force about point A equals .... newton.cm.

(a) 40 (b) zero (c) 200 (d) 400

2. ABC is an equilateral triangle , length of its side is 8 cm. , a force of magnitude 15 N. acts along $\overrightarrow{BC}$, then the magnitude of moment of this force about A is .... newton.cm.

(a) $40\sqrt{3}$ (b) 60 (c) $60\sqrt{3}$ (d) 120

3. A force of magnitude 70 N. , acts along $\overrightarrow{AB}$ where ABCD is square with side length 10 cm. , then the norm of the moment of this force about centre of the square is .... newton.cm.

(a) $175\sqrt{2}$ (b) 350 (c) $350\sqrt{2}$ (d) 700

4. Force of magnitude 5 N. acts in the straight line $3x + 4y = 5$, then the magnitude of its moment about point A $(1, -1)$ is ....

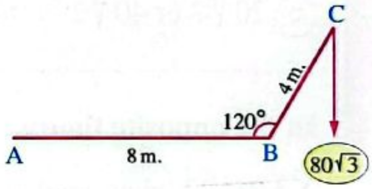
(a) 6 (b) 5 (c) $\frac{6}{5}$ (d) $\frac{5}{6}$

5. **In the opposite figure :**

The algebraic measure of the force $80\sqrt{3}$ N. about A equals .... N. m.

(a) $-80\sqrt{3}$ (b) $-800\sqrt{3}$

(c) -480 (d) $-480 - 640\sqrt{3}$

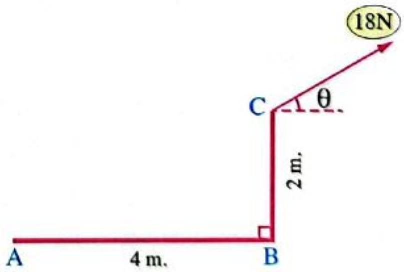


6. **In the opposite figure :**

If the moment of the force 18 N. about A equals zero , then $\tan\theta =$ ....

(a) $\frac{3}{4}$ (b) $\frac{2}{3}$

(c) $\frac{1}{2}$ (d) $\frac{1}{3}$

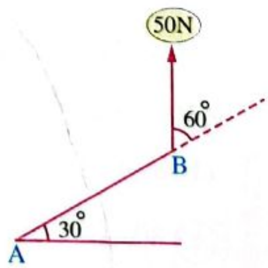


7. **In the opposite figure :**

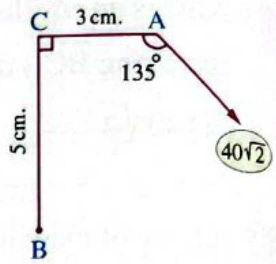
If the moment of the force 50 N. about the point A equals $100\sqrt{3}$ N.cm. , then AB = ... cm.

(a) 2 (b) 3

(c) 4 (d) 5



8 **In the opposite figure :**



Norm of moment of the force whose magnitude $F = 40\sqrt{2}$ newtons about the point B equals .... N.cm.

ⓐ 320 ⓑ $200\sqrt{2}$

ⓒ $120\sqrt{2}$ ⓓ $80\sqrt{17}$

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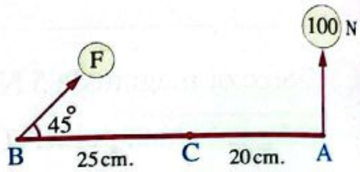
9 **In the opposite figure :**



If the magnitude of the sum of moments of the two forces 100 , F newton about C equals 1000 N.cm.

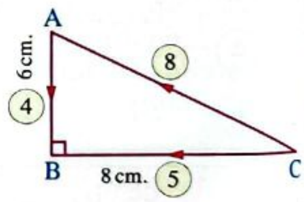
, then F = ... N.

ⓐ 20 or 40 ⓑ 40 or 120

ⓒ $20\sqrt{2}$ or $40\sqrt{2}$ ⓓ $40\sqrt{2}$ or $120\sqrt{2}$

---

10 **In the opposite figure :**



Δ ABC is a right-angled at B , forces of magnitudes 8 , 4 and 5 N. , act along $\overrightarrow{CA}$, $\overrightarrow{AB}$ and $\overrightarrow{CB}$, then sum of moments of the forces about A = ... N.cm.

ⓐ 30 ⓑ – 30

ⓒ 20 ⓓ 38.4

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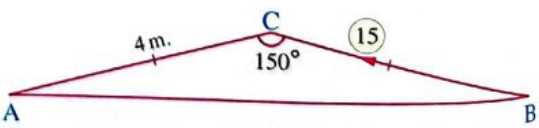
11 **In the opposite figure :**



Δ ABC is an isosceles triangle in which

BC = AC = 4 cm. , m ($\angle$ C) = 150°

If force $\overrightarrow{F}$ acts in $\overrightarrow{BC}$ and F = 15 newtons

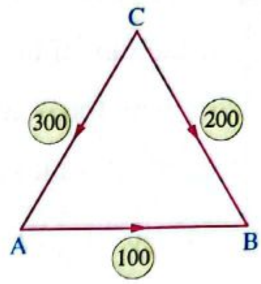
, then the algebraic measure of the moment of $\overrightarrow{F}$ about A = ... newtons.cm.

ⓐ 30 ⓑ $30\sqrt{3}$

ⓒ $-30\sqrt{3}$ ⓓ – 30

12 **In the opposite figure :**

ABC is an equilateral triangle of sides length 12 cm. , forces act on its sides in the indicated direction in the figure , then the sum of the algebraic moments of these forces about the point of intersection of its medians = ... newton.cm.



(a) $400\sqrt{3}$ (b) $800\sqrt{3}$ (c) $200\sqrt{3}$ (d) $-6\sqrt{3}$

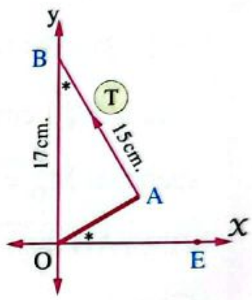
---

13 **In the opposite figure :**

If AB = 15 cm. , OB = 17 cm.

, m (∠ ABO) = m (∠ AOE)

The tension in the string $\overline{AB}$ equals 10 newtons , then the magnitude of the moment of the tension about O equals .... N.cm.

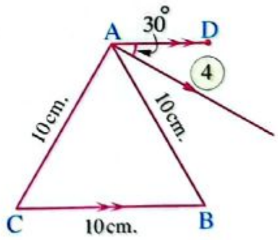


(a) 50 (b) 80 (c) 150 (d) 170

---

14 *(1st Session 2021)* **In the opposite figure :**

ABC is an equilateral triangle of side length 10 cm. , a force of magnitude 4 newton acts at the point A in direction makes an angle of measure 30° with $\overline{AD}$ where $\overline{AD}$ // $\overline{BC}$, then the algebraic measure of the moment of the force about B = ... newton.cm.

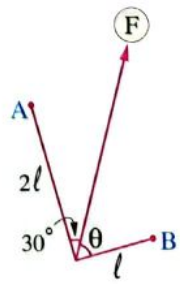


(a) 20 (b) − 20 (c) 40 (d) − 40

---

15 **In the opposite figure :**

If the magnitude of the moment of force F about A equals the magnitude of it moment about B , then m ($\hat{\theta}$) = ...

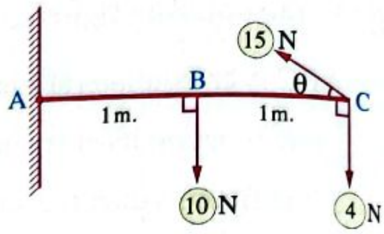


(a) 30° (b) 45°

(c) 60° (d) 90°

16 **In the opposite figure :**

If the sum of the moments of these forces about A equals 2 N.m. , then $\theta =$ ....



(a) $\sin^{-1}\left(\frac{3}{5}\right)$ (b) $\sin^{-1}\left(\frac{1}{2}\right)$

(c) $\sin^{-1}\left(\frac{2}{3}\right)$ (d) $\sin^{-1}\left(\frac{1}{3}\right)$

---

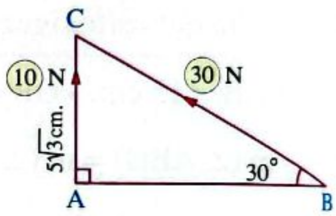
17 **In the opposite figure :**

$m(\angle B) = 30°$, $m(\angle A) = 90°$

, $AC = 5\sqrt{3}$ cm. , $D \in \overline{AB}$

such that $M_D =$ zero

, then AD = ... cm.



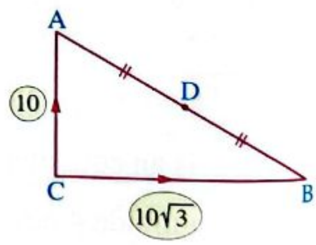
(a) 6 (b) 7 (c) 8 (d) 9

---

18 **In the opposite figure :**

ABC is a triangle , $m(\angle A) = 2\, m(\angle B)$

, D is the midpoint of $\overline{AB}$ two forces 10 N. , $10\sqrt{3}$ N. acts in $\overrightarrow{CA}$, $\overrightarrow{CB}$ respectively if the resultant of the two forces passes through D , then $m(\angle B) =$ ....°



(a) 90 (b) 60 (c) 45 (d) 30

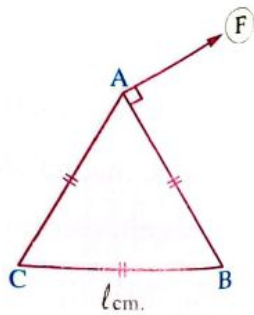
---

19 **In the opposite figure :**

ABC is an equilateral triangle of side length ℓ cm.

Force of magnitude 10 N. acts perperndicular to $\overline{AB}$

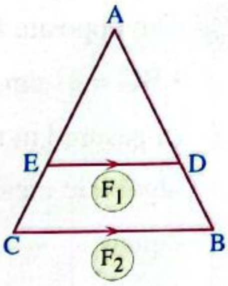
The magnitude of moment of this force about C equals 40 N.cm. , then $\ell =$ .... cm.



(a) 8 (b) 6

(c) 4 (d) 3

20 In the opposite figure :



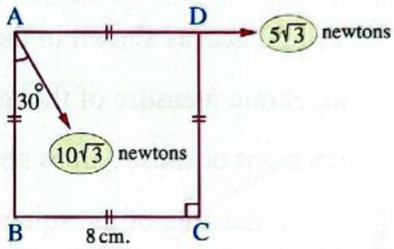
If the two forces $\vec{F}_1$, $\vec{F}_2$ are completely represented by the two vectors $\overrightarrow{ED}$, $\overrightarrow{CB}$ where the length unit represents a force unit and AD : DB = 3 : 2

, then $\dfrac{\text{The magnitude of the moment of } \vec{F}_1 \text{ about A}}{\text{The magnitude of the moment of } \vec{F}_2 \text{ about A}} = \ldots\ldots\ldots\ldots$

(a) 3 : 2 (b) 3 : 5 (c) 9 : 4 (d) 9 : 25

---

21 In the opposite figure :



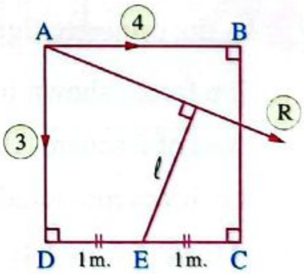
Sum of moments of the forces about the point C = ……………

(a) $40\sqrt{3}$ (b) $120 - 80\sqrt{3}$

(c) $80\sqrt{3}$ (d) $120\sqrt{3}$

---

22 In the opposite figure :



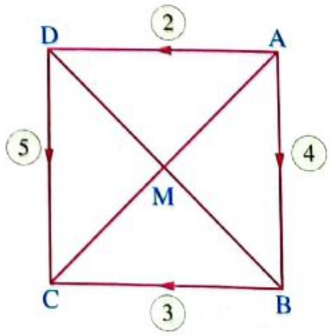
ABCD is a square of side length 2 m. , two forces 4 , 3 kg.wt. acts along $\overrightarrow{AB}$, $\overrightarrow{AD}$ respectively If their resultant $\vec{R}$, ℓ is the length of the perpendicular from E (midpoint of $\overline{CD}$) to the line of action of $\vec{R}$, then ……………

(a) R = 5 kg.wt. , ℓ = 1.5 m. (b) R = 5 kg.wt. , ℓ = 1 m.

(c) R = 5 kg.wt. , $\ell = \sqrt{2}$ m (d) R = 5 kg.wt. , ℓ = 1.2 m.

---

23 In the opposite figure :

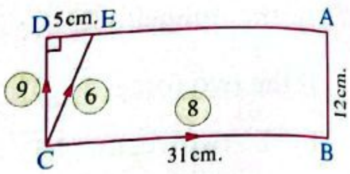


ABCD is a square. Forces of magnitudes 4 , 3 , 5 , 2 N. act as shown in the figure , then the sum of the algebraic measures of the moments of these forces about M is ……………

(a) positive. (b) negative.

(c) zero (d) positive or negative.

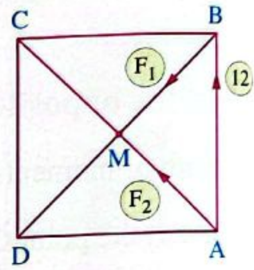
24 The opposite figure is a rectangle , AB = 12 cm. , BC = 31 cm. , DE = 5 cm. set of forces (measured in newtons) act as shown in the figure , then the algebraic measure of the moments of these forces about A equals .... N. cm.



(a) -327 (b) -273 (c) 327 (d) $574\frac{5}{13}$

25 In the opposite figure :

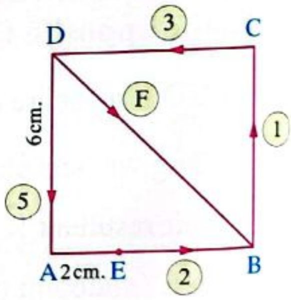
ABCD is a square. The forces 12 N. , F_1 N. , F_2 N. acts as shown in the figure. If the algebraic measure of the moment of the resultant of these forces about M = 120 N.cm. , then the area of the square = ... cm^2



(a) 100 (b) 200 (c) 300 (d) 400

26 In the opposite figure :

The forces shown in the figure acts along the sides of a square ABCD with side length 6 cm. If the forces measured in newton and the resultant of these forces acts at $E \in \overline{AB}$ where AE = 2 cm. , then F = ... N.



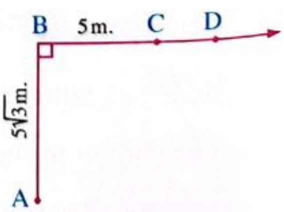
(a) $\sqrt{2}$ (b) $2\sqrt{2}$ (c) $8\sqrt{2}$ (d) $12\sqrt{2}$

27 In the opposite figure :

$\overline{AB} \perp \overline{BD}$, AB = $5\sqrt{3}$ m. , BC = 5 cm.

Force $\vec{F}$ acts at point C and acts in direction inclined to $\overrightarrow{CD}$ at an angle θ downward.

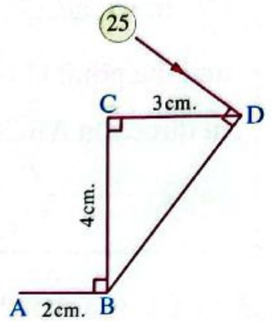
If the moment of the force $\vec{F}$ vanished about the point A , then measure of angle θ = ...°



(a) 30 (b) 60 (c) 120 (d) 150

28 ***(2nd Session 2021)*** **In the opposite figure :**

A force $\vec{F}$ of magnitude 25 newton acts at the point D such that $\vec{F} \perp \overline{DB}$, if DC = 3 cm. , BC = 4 cm. , AB = 2 cm. , then the algebraic measure of the moment of the force $\vec{F}$ about the point A equals .... newton.cm.



(a) 125 (b) 155

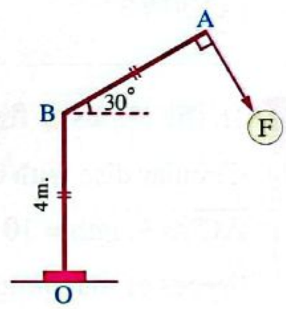
(c) – 155 (d) – 125

---

29 **In the opposite figure :**

If the magnitude of the moment of the force $\vec{F}$ about point (B) equals 72 N.m.

, then the magnitude of the moment of force $\vec{F}$ about (O) equals .... N.m.



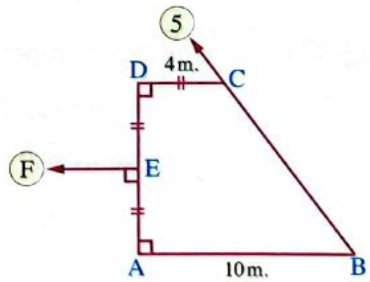
(a) $36\sqrt{3}$ (b) $54\sqrt{3}$

(c) 72 (d) 108

---

30 **In the opposite figure :**

ABCD is a trapezium , force of magnitude 5 N. acts along $\overline{BC}$ Another force $\vec{F}$ acts at E as shown in the figure , then the algebraic measure of the sum of the moments of these two forces about A equals 60 N.m. , then F = ... N.



(a) 2 (b) 5 (c) 8 (d) 10

---

31 ABCD is a rectangle which AB = 9 cm. , BC = 12 cm. Forces of magnitudes 2 , 4 , 5 , 4 and 10 N. act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{DA}$ and $\overrightarrow{AC}$ respectively , then the sum of moments of these forces about the point B equals .... N.cm.

(a) 96 (b) 66 (c) 84 (d) 24

32 ABCD is a rectangle which AB = 6 cm. , BC = 8 cm. Forces of magnitudes 5 , 8 , 6 and 10 gm.wt. act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$ and $\overrightarrow{CA}$ respectively.
and the point $O \in \overline{BC}$, which sum of moments of these forces about O = 45 gm.wt.cm. in direction ABCD , then BO = ... cm.

(a) 2 (b) 3 (c) 4 (d) 5

---

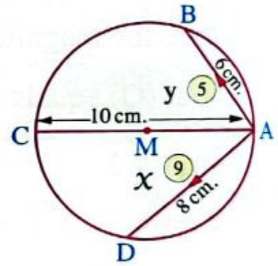
33 ABCD is a rhombus whose side length is 12 cm. , m ($\angle$ A) = 60°
Forces of magnitude 11 , 6 , 5 , 7 newton act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{DB}$ respectively.
, then the algebraic sum of the moments of these forces about the point of intersection of the diagonals equal .... N.cm.

(a) $30\sqrt{3}$ (b) $45\sqrt{3}$ (c) $60\sqrt{3}$ (d) $75\sqrt{3}$

---

34 **In the opposite figure :**

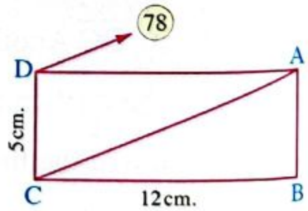
Circular disc with diameter $\overline{AC}$ its length = 10 cm. , AB = 6 cm. , AD = 8 cm.
Forces of magnitudes 5 and 9 N. act along $\overrightarrow{AB}$ and $\overrightarrow{AD}$ respectively , then M_M = ... N.cm.



(a) – 7 (b) – 14 (c) 14 (d) 47

---

35 The opposite figure represents a rectangle.
The force of magnitude 78 N. acts at point D in direction parallel to $\overline{AC}$. Then the magnitude of the moment of the force about B = ... N.cm.



(a) 60 (b) 360 (c) 720 (d) 1440

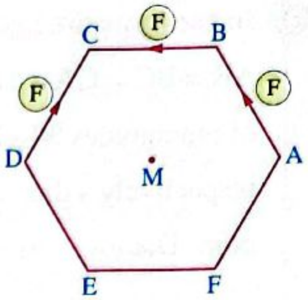
---

36 ABCD is a right-angled trapezium at B in which $\overline{AD} \parallel \overline{BC}$, AB = 8 cm. , BC = 15 cm. and AD = 9 cm. Forces of magnitudes F , 44 and 68 gm.wt. act in $\overrightarrow{DA}$, $\overrightarrow{DC}$ and $\overrightarrow{AC}$ respectively. If the line of action of the resultant passes through B. Then the value of F = ... gm.wt.

(a) 114 (b) 126 (c) 156 (d) 184

37 **In the opposite figure :**

ABCDEF is a regular hexagon , its side length is (ℓ) three equal forces each of magnitude (F) act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$ respectively , then the sum of moments of these forces about (M) (the centre of the hexagon) equals .... moment unit.



(a) $\frac{3\sqrt{3}}{2} F \ell$

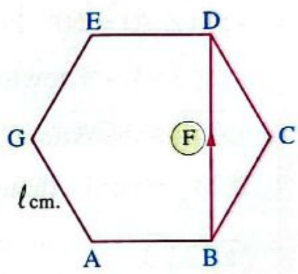
(b) $\frac{\sqrt{3}}{3} F \ell$

(c) $\frac{\sqrt{3}}{2} F \ell$

(d) $\frac{-\sqrt{3}}{2} F \ell$

---

38 The opposite figure represents a regular hexagon. Its side length is ℓ cm. force of magnitude F acts along $\overrightarrow{BD}$, then $\overrightarrow{M}_A + \overrightarrow{M}_B + \overrightarrow{M}_D =$ ....



(a) M_C

(b) M_E

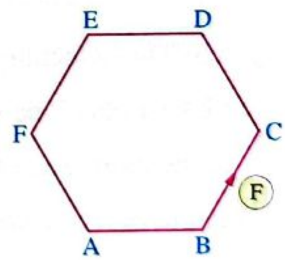
(c) $-M_C$

(d) M_G

---

39 The opposite figure represents a regular hexagon of side length ℓ cm. Force of magnitude F acts in $\overrightarrow{BC}$ direction then :

$M_A + M_D =$ .... $(M_F + M_E)$



(a) $\frac{1}{2}$

(b) 2

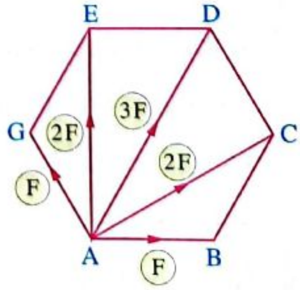
(c) 1

(d) $\frac{1}{4}$

---

40 If the sum of moments of the forces act on the opposite regular hexagon vanishes about a point on the plane such as N.

, then N $\in$ ....



(a) $\overleftrightarrow{AC}$

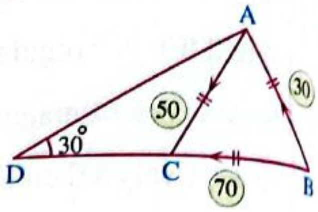
(b) $\overleftrightarrow{AD}$

(c) $\overleftrightarrow{AE}$

(d) $\overleftrightarrow{AG}$

41 **In the opposite figure :**

$AB = BC = CA = 12$ cm. , $m(\angle ADB) = 30°$. If the forces of magnitudes 30 , 50 and 70 newton act along $\overrightarrow{BA}$, $\overrightarrow{AC}$ and $\overrightarrow{BC}$ respectively , then the sum of moments of the forces about point D = ... newton.cm.



(a) $60\sqrt{3}$
(b) $-60\sqrt{3}$
(c) $360\sqrt{3}$
(d) $-300\sqrt{3}$

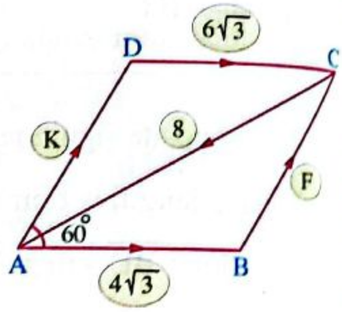
---

42 **In the opposite figure :**

ABCD is a rhombus of side length ℓ cm.

, $m(\angle A) = 60°$. Forces of magnitudes $4\sqrt{3}$, F , $6\sqrt{3}$, k , 8 newton act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{AD}$ and $\overrightarrow{CA}$

If M_A = zero , then F = ... newtons.



(a) $2\sqrt{3}$
(b) $4\sqrt{3}$
(c) $5\sqrt{3}$
(d) $6\sqrt{3}$

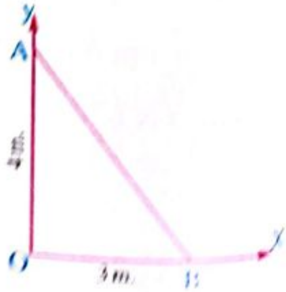
---

43 ABCD is a rectangle in which AB = 8 cm. , BC = 6 cm. Forces of magnitudes 12 , 10 , F , k newton act along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$, $\overrightarrow{AD}$ respectively. If the algebraic sum of the moment of these forces about each of the points C and M vanishes where M is the centre of the rectangle , then : F + k = ... newton.

(a) $\frac{40}{3}$
(b) $\frac{67}{3}$
(c) $\frac{73}{3}$
(d) $\frac{97}{3}$

---

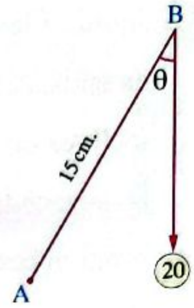
44 A force $\vec{F}$ act on the plane of ΔAOB , if the algebraic measure of the moment of the force $\vec{F}$ about O , A and B is 84 , − 100 and zero respectively. Then the magnitude of $\vec{F}$ = ... N. and makes an angle of measure .... to $\overrightarrow{OX}$.



(a) 54 , 30° 20′
(b) 54 , 148° 40′
(c) 16 , 31° 20′
(d) 16 , 148° 40′

45 **In the opposite figure :**

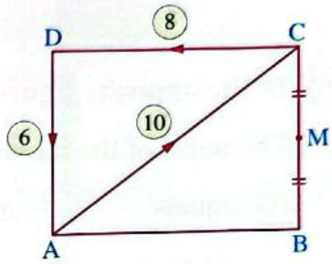
Magnitude of the moment of the force 20 newton. about the point A ∈ ....



ⓐ [0 , 15]　ⓑ [0 , 20]
ⓒ [0 , 30]　ⓓ [0 , 300]

46 **In the opposite figure :**

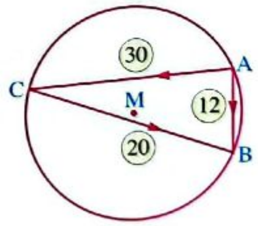
ABCD is a rectangle in which AB = 16 cm. , BC = 12 cm. , M is the midpoint of $\overline{BC}$, the forces of magnitudes 6 , 10 , 8 newtons act in the directions $\overrightarrow{DA}$, $\overrightarrow{AC}$, $\overrightarrow{CD}$ respectively.



A force of magnitude 5 newton. act at M. If the algebraic measure of moments of these forces about B equals 111 moment units. , then measure of the angle between the force 5 and $\overline{BC}$ equals ....

ⓐ 30°　ⓑ 60°　ⓒ 45°　ⓓ $\tan^{-1}\frac{4}{3}$

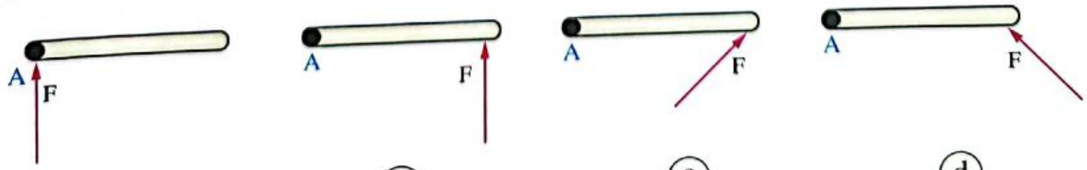
47 ABC is a triangle inscribed in a circle , AB = 10 cm. , AC = 24 cm. , BC = $8\sqrt{10}$ cm. the radius length of the circle is 13 cm. forces of magnitudes 12 , 30 , 20 gm.wt. act along $\overrightarrow{AB}$, $\overrightarrow{AC}$, $\overrightarrow{CB}$ respectively , then the algebraic sum of moments of these forces about the centre of the circle equals .... moment units.



ⓐ 33　ⓑ 132　ⓒ 66　ⓓ 354

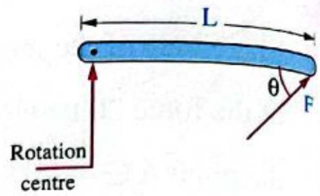
3 Choose the correct answer from those givens :

1 The following figures represent a door attached with a hinge at A. If a force $\vec{F}$ acts on the door. In which of these figures the force $\vec{F}$ has the greatest moment about A ?



ⓐ　ⓑ　ⓒ　ⓓ

2 A rod of length L. It can rotate easily about a point at one of its ends. A force of a magnitude F acts on the other end and inclines on the rod with an angle of measure θ , if $\vec{F}$ should be perpendicular to the rod , at which distance from the rotation centre can F affect such that it has the same moment.

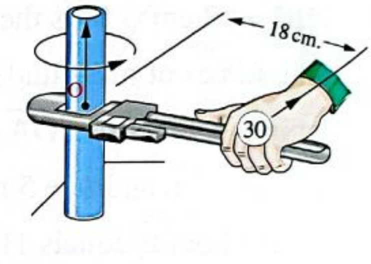


(a) L sin θ
(b) L cos θ
(c) L
(d) L tan θ

---

3 **In the opposite figure :**

The norm of the moment of the force about the origin point (O) equals .... moment unit.



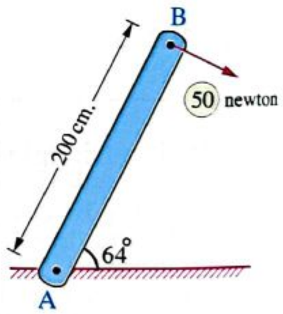
(a) – 540
(b) 270
(c) – 270
(d) 540

---

4 **In the opposite figure :**

A rod fixed by a hinge at A

If a vertical force of a magnitude 50 newton acts on the end B in direction perpendicular to the rod , then the norm of the moment about A is equal to .... newton.metre.



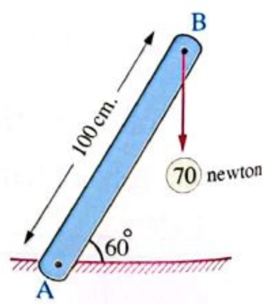
(a) 10^4
(b) 10^2
(c) 10000 sin 64°
(d) 100 cos 64°

---

5 **In the opposite figure :**

A rod fixed by a hinge at A

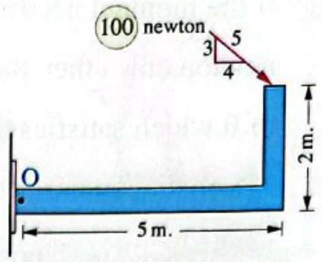
If a vertical force of a magnitude 70 newton acts on the end B downward , then the norm of the moment of the force about A is equal to .... newtons. metre.



(a) 35
(b) $35\sqrt{3}$
(c) 70
(d) $70\sqrt{3}$

6 In the opposite figure :

The algebraic measure of the moment of the force about point (O) equals .... newtons.m



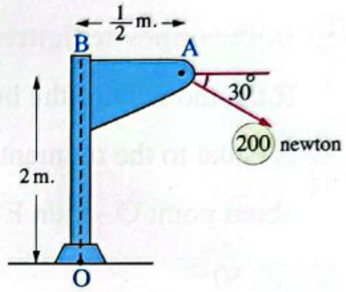
(a) – 520 (b) – 460

(c) 460 (d) 520

---

7 In the opposite figure :

The magnitude of the moment of the force about (O) ≃ .... newtons.m.



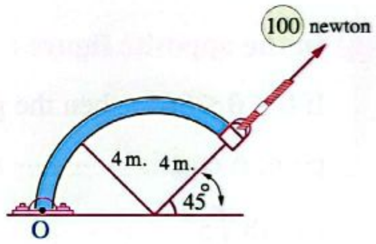
(a) 198.7 (b) 286.6

(c) 396.4 (d) 302.5

---

8 In the opposite figure :

The algebraic measure of the moment of the force about (O) equals .... newtons.m.



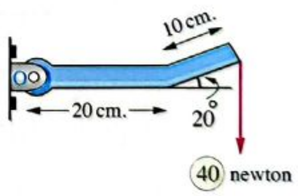
(a) $200\sqrt{2}$ (b) $100\sqrt{2}$

(c) $200\sqrt{3}$ (d) 200

---

9 In the opposite figure :

The algebraic measure of the moment of the force about (O) ≃ .... newtons.cm.



(a) – 1200 (b) – 936.81

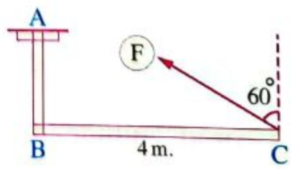
(c) – 410.42 (d) – 1175.88

---

10 In the opposite figure :

Force (F) of magnitude 10 N. acts at C and the algebraic measure of its moment about A equals 5 N.m.

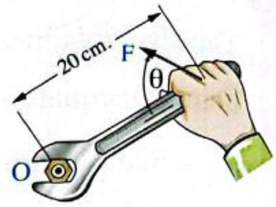
, then AB = ... m.



(a) $2\sqrt{3}$ (b) $\sqrt{3}$

(c) 2 (d) 4

11 If the moment needed to rotate a nail about O is equal 400 newton cm. , then the least value of the force F and the value of θ which satisfies the nail rotation are ....

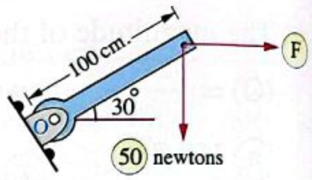


(a) 20 newtons , 45° (b) 20 newtons , 90°

(c) 10 newtons , 90° (d) 40 newtons , 90°

12 In the opposite figure :

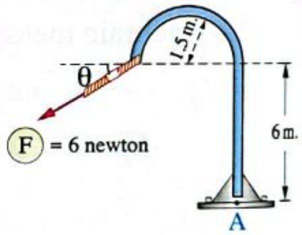
If the moment of the horizontal force F about point O is equal to the moment of the vertical force 50 newton about point O , then F = ... newtons.



(a) 50 (b) $50\sqrt{3}$ (c) $100\sqrt{3}$ (d) 2500

13 In the opposite figure :

If $0 \le \theta \le 90°$, then the greatest value of the force moment F about point A equals .... newton.m.



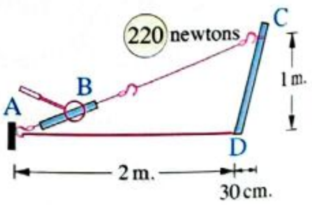
(a) $18\sqrt{5}$ (b) 36

(c) 18 (d) $36\sqrt{5}$

14 In the opposite figure :

A winch puller $\overline{AB}$ acting on an inclined fence $\overline{CD}$

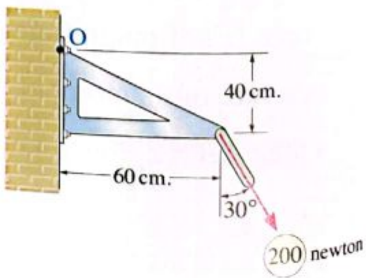
Then the magnitude of the moment of the tension force about point D = ... N.m.



(a) 175.4 (b) 201.77 (c) 440 (d) 2807.19

15 In the opposite figure :

The algebraic measure of the moment of the force of magnitude 200 N about the point O = ... N.cm.

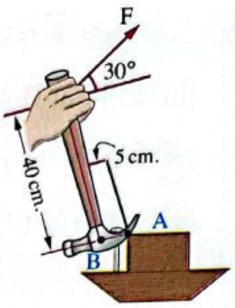


(a) – 6392.3 (b) 6392.3

(c) – 10392.3 (d) 40000

16 The opposite figure illustrates the force F needed to remove a nail at B if the magnitude of the moment of the force about point A needed to remove the nail is equal to 200 newtons.cm.

, then F = ... N.



(a) 5.77 (b) 80

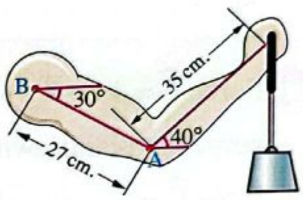
(c) 5.38 (d) 3.58

---

17 **In the opposite figure :**

Person carry load by his hand , if norm of moment of this load about the point A equals 80 N.m. , then the norm of moment of this load about

B = ... N.m.



(a) 149.77 (b) 298.38

(c) 2.98 (d) 100.39

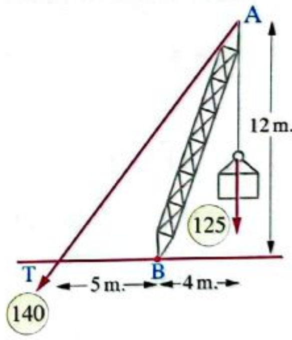
---

18 **In the opposite figure :**

$\overline{AB}$ represents a crane for lifting the goods.

If the tension in the string is equal to 140 newtons, and the weight of the box is 125 newtons,

then the sum of the two moments of the two forces about B = ... newton.m.



(a) 50 (b) 60

(c) 70 (d) 80

4 Choose the correct answer from those givens :

1 The force $\vec{F} = 4\hat{i} + 5\hat{j} - 3\hat{k}$ acts at the point A (2 , – 3 , 4) , then the moment of this force about origin equals ....

(a) $-11\hat{i} + 22\hat{j} + 22\hat{k}$ (b) $-8\hat{i} - 15\hat{j} - 12\hat{k}$

(c) $16\hat{i} - 15\hat{j} - 6\hat{k}$ (d) $-11\hat{i} + \hat{j} + 22\hat{k}$

2 The force $\vec{F} = 2\hat{i} - \hat{j} + 5\hat{k}$ acts at the point $A = (1, 0, -3)$, then the moment of this force about B whose position vector $\hat{j} + 3\hat{k}$ equals ....

(a) $-2\hat{i} - 17\hat{j} + \hat{k}$
(b) $-11\hat{i} + \hat{k}$
(c) $-11\hat{i} - 17\hat{j} + \hat{k}$
(d) $-11\hat{i} - 17\hat{j}$

---

3 The moment of the force $\vec{F} = 3\hat{i} - \hat{j}$ about a point is $21\hat{i} + 7\hat{k}$, then the length of the perpendicular drawn from this point to the line of action of the force in length unit is ....

(a) $\frac{1}{7}$
(b) $\frac{1}{7}\sqrt{10}$
(c) 7
(d) $10\sqrt{2}$

---

4 Force $\vec{F} = 4\hat{i} + 4\hat{j} + 7\hat{k}$ acts at the point A $(12, 6, -5)$, then the length of the perpendicular drawn from the point B $(3, 4, 1)$ on the line of action of the force $\vec{F} \simeq$ .... length unit.

(a) 7
(b) 9
(c) 11
(d) 13

---

5 Let : $\vec{F} = (-1, 3, -2)$ acts at the point $(4, -1, 0)$, then the moment component of $\vec{F}$ about z-axis equals ....

(a) -8
(b) 3
(c) 11
(d) 13

---

6 Force $\vec{F} = 15\hat{i} - 25\hat{j} + 40\hat{k}$ acts at the point A $(-3, -3, 2)$, then the component of the moment of $\vec{F}$ about the y-axis equals ....

(a) 150
(b) 120
(c) 100
(d) 75

---

7 Force $\vec{F}$ of magnitude 5 N. acts at the point A $(0, 6, 0)$ and acts parallel to z-axis, then the moment of $\vec{F}$ about B $(6, 0, 0)$ is ....

(a) $30\hat{k}$
(b) $30\hat{i} + 30\hat{j}$
(c) $30\hat{i} + 30\hat{j} + 30\hat{k}$
(d) $30\hat{i} - 30\hat{j}$

---

8 ***(Trial 2021)*** Force $\vec{F}$ of magnitude 10 kg.wt. acts at point A $(2, 5, 3)$ and in direction parallel to the positive direction of the y-axis, then the moment of $\vec{F}$ about the origin equals ....

(a) $30\hat{i} - 20\hat{k}$
(b) $-30\hat{i} + 20\hat{k}$
(c) $20\hat{i} - 30\hat{k}$
(d) $30\hat{i} + 20\hat{k}$

9 A force $\overrightarrow{F}$ parallel to the x-axis acts at point A (2 , – 1 , 3) if the moment of $\overrightarrow{F}$ about the origin point is equal to $21\hat{j} + 7\hat{k}$, then $\overrightarrow{F}$ = ...

(a) $7\hat{i}$
(b) $7\hat{i} + 2\hat{j}$
(c) $21\hat{i}$
(d) $7\hat{j}$

---

10 If the moment of the force $\overrightarrow{F} = 2\hat{i} + 3\hat{j} - \hat{k}$ about origin equals $-5\hat{i} + 3\hat{j} - \hat{k}$ and the force passes through the point (m , 2 , ℓ) , then the value of $m^2 + \ell$ = ...

(a) 8
(b) 4
(c) 2
(d) 1

---

11 If : $\overrightarrow{F} = 2\hat{i} + \ell\hat{j} - \hat{k}$ acts at point A (4 , – 2 , 0) and the moment of $\overrightarrow{F}$ about the origin equals $2\hat{i} + 4\hat{j} + 16\hat{k}$, then ℓ = ...

(a) 1
(b) 2
(c) 3
(d) 4

---

12 The force : $\overrightarrow{F} = p\hat{i} + q\hat{j} - 2\hat{k}$ acts at the point A whose position vector with respect to the origin is $\overrightarrow{r}$ = (3 , 1 , 1) , if the components of moment of $\overrightarrow{F}$ about the x-axis and y-axis are – 1 , – 8 respectively , then p + q = ... moment unit.

(a) – 15
(b) 15
(c) – 14
(d) 14

---

13 Force $\overrightarrow{F}$ of magnitude 90 N. acts along $\overrightarrow{AB}$ where A (11 , 0 , 4) , B (7 , 7 , 0) , then the moment of the force $\overrightarrow{F}$ about C (0 , 6 , 5) equals ....

(a) $170\hat{i} - 400\hat{j} + 530\hat{k}$
(b) $310\hat{i} - 480\hat{j} + 530\hat{k}$
(c) $310\hat{i} + 480\hat{j} + 530\hat{k}$
(d) $170\hat{i} + 400\hat{j} + 1010\hat{k}$

---

14 If the force $\overrightarrow{F} = (F_x , F_y , F_z)$ acts at the point A (2 , 3 , – 1) , then $\overrightarrow{F}_x$ is capable to make a moment about ....

(a) the x-axis only.
(b) both the x-axis and y-axis only.
(c) both the y-axis and z-axis only.
(d) all axes x , y and z

15 If $\overrightarrow{F_1} = (a , b , c)$, $\overrightarrow{F_2} = (d , b , c)$ act at the point (x , y , z) , which of the following statements is true where $a \neq d$

(a) The moment component of $\overrightarrow{F_1}$ about the x-axis = the moment component of $\overrightarrow{F_2}$ about the x-axis.

(b) The moment component of $\overrightarrow{F_1}$ about the y-axis = the moment component of $\overrightarrow{F_2}$ about the y-axis.

(c) The moment component of $\overrightarrow{F_1}$ about the z-axis = the moment component of $\overrightarrow{F_2}$ about the z-axis.

(d) The moment of $\overrightarrow{F_1}$ about the origin = the moment of $\overrightarrow{F_2}$ about the origin.

---

16 *(1st Session 2021)* If the force $\vec{F} = \hat{i} - 2\hat{j} + 4\hat{k}$ acts at the point B where B lies on y-axis. If the norm of the moment of $\vec{F}$ about the origin point $= \sqrt{85}$ moment unit , then the y-coordinate of the point B = ...

(a) ± 2.5 (b) $\pm\sqrt{3}$ (c) $\pm\sqrt{5}$ (d) ± 5

---

17 If force $\vec{F}$ lies in the x y-plane and its line of action does not pass through the origin , then its moment does not vanish about ....

(a) the x-axis (b) the y-axis

(c) the z-axis (d) all the previous.

---

18 If the moment vector of the force $\vec{F} = 5\hat{i} - 10\hat{j} - 7\hat{k}$ about the origin equals $40\hat{i} + 41\hat{j} - 30\hat{k}$, then the coordinates of the point where the line of action of the force $\vec{F}$ intersects the xz-plane is ....

(a) $(3 , 0 , 4)$ (b) $(4 , 0 , 3)$ (c) $(3 , 0 , 3)$ (d) $(4 , 0 , 4)$

---

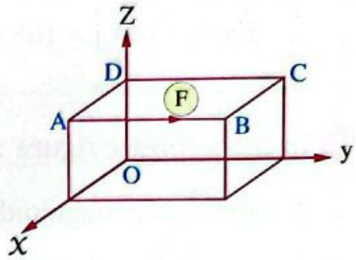
19 *(2nd Session 2021)* If the line of action of $\vec{F} = \hat{i} + 2\hat{j} + \hat{k}$ intersects z-axis at the point A and the component of the moment of the force $\vec{F}$ about y-axis equals 5 moment unit , then the point A is ....

(a) $(0 , 0 , -5)$ (b) $(0 , 0 , 10)$ (c) $(0 , 0 , 5)$ (d) $(0 , 0 , -10)$

20 If the force $\overrightarrow{F} = 2\hat{i} - 2\hat{j} + \hat{k}$ acts at the point $(3, 1, -1)$ and its line of action touches a sphere, its centre at the origin (O), then the area of the sphere = ... area units.

(a) 10π (b) 20π (c) 30π (d) 40π

21 **In the opposite figure :**

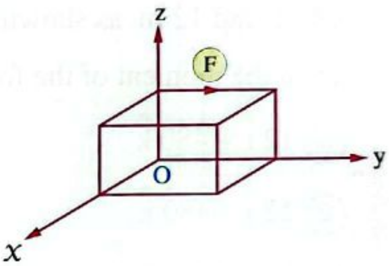


The moment of the force $\overrightarrow{F}$ vanished about ....

(a) the x-axis. (b) the y-axis.

(c) the z-axis. (d) the origin.

22 **In the opposite figure :**



The moment of the force $\overrightarrow{F}$ vanishes about ....

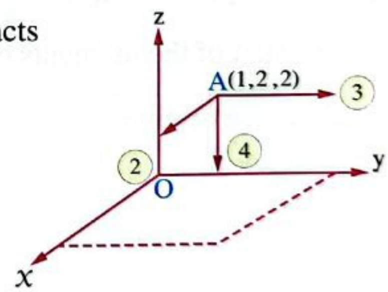
(a) the x-axis only.

(b) both the y-axis and z-axis.

(c) both the x-axis and z-axis.

(d) the origin.

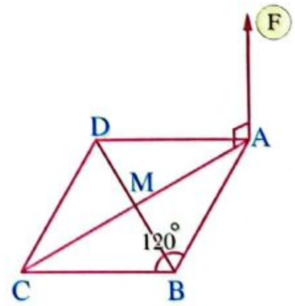
23 The opposite figure shows the components of force $\overrightarrow{F}$ which acts at point A (1, 2, 2), then the moment of $\overrightarrow{F}$ about the origin equals ....



(a) $(1, 2, 2)$ (b) $(-14, 8, -1)$

(c) $(-14, -8, -1)$ (d) $(14, -8, 1)$

24 **In the opposite figure :**



ABCD is a rhombus of side length 5 cm., m ($\angle$B) = 120° Its diagonals intersect at M. Force of magnitude (F) N. acts at A perpendicular to the plane of the rhombus ABCD and its moment about C equals 300 N. cm., then :

First : F = ... N.

(a) $10\sqrt{3}$ (b) $15\sqrt{5}$ (c) $20\sqrt{3}$ (d) $25\sqrt{3}$

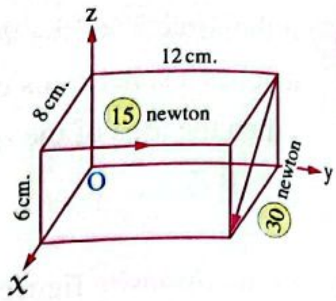
Second : $M_B : M_M$ = ...

(a) $2 : \sqrt{3}$ (b) $1 : \sqrt{3}$ (c) $5 : \sqrt{3}$ (d) $\sqrt{3} : 2$

25 **In the opposite figure :**

The sum of moments

of the forces about O = ...



ⓐ $306\,\hat{i} + 144\,\hat{j} + 168\,\hat{k}$ ⓑ $-306\,\hat{i} + 144\,\hat{j} - 168\,\hat{k}$

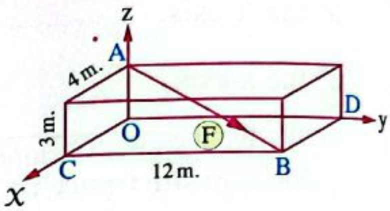
ⓒ $306\,\hat{i} - 144\,\hat{j} - 168\,\hat{k}$ ⓓ $-306\,\hat{i} - 144\,\hat{j} + 168\,\hat{k}$

---

26 **In the opposite figure :**

A force $\vec{F}$ of a magnitude 130 newton acts along the diagonal $\overrightarrow{AB}$ in the cuboid whose dimensions are 3 m. , 4 m. and 12 m. as shown in the figure.

Then the moment of the force $\vec{F}$ about point D = ...



ⓐ $12\,\hat{i} + 480\,\hat{k}$ ⓑ $120\,\hat{j} + 480\,\hat{k}$

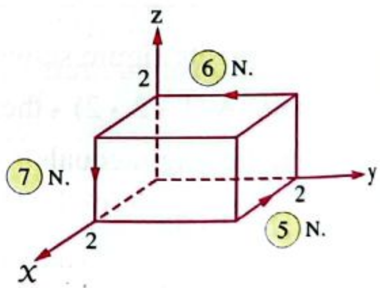
ⓒ $12\,\hat{j} - 480\,\hat{k}$ ⓓ $12\,\hat{i} + 480\,\hat{j}$

---

27 **In the opposite figure :**

The sum of the moments of the forces

about the origin = ...



ⓐ $\vec{O}$

ⓑ $5\,\hat{i} + 6\,\hat{j} + 7\,\hat{k}$

ⓒ $10\,\hat{i} + 12\,\hat{j} + 14\,\hat{k}$

ⓓ $12\,\hat{i} + 14\,\hat{j} + 10\,\hat{k}$

---

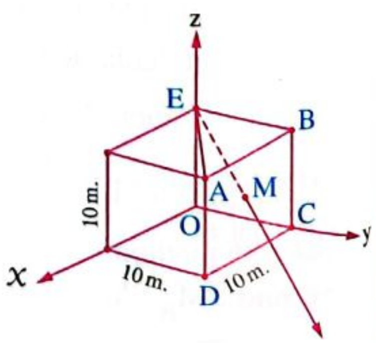
28 **In the opposite figure :**

Force of a magnituide $25\sqrt{6}$ newton acts in $\overrightarrow{EM}$

where M is the centre of square ABCD

, then the moment component of

the force with respect to the y-axis ....



ⓐ -500 ⓑ 250 ⓒ 125 ⓓ zero

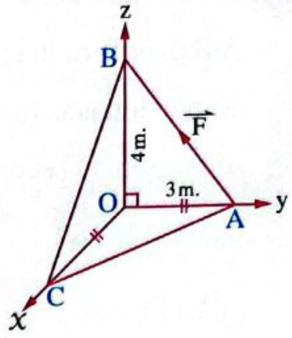
29 **In the opposite figure :**

If $\|\vec{F}\| = 50$ N. acts along $\overrightarrow{AB}$

, then the magnitude of moment

of $\vec{F}$ about the X-axis

equals .... N.m.



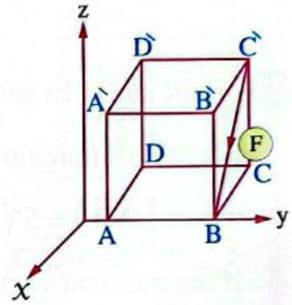
(a) 30
(b) 90
(c) 120
(d) 150

30 **In the opposite figure :**

A cube has side length 5 cm.

A (0 , 3 , 0) , $\|\vec{F}\| = 15\sqrt{2}$ N.

, then $\overrightarrow{M_D}$ = ...

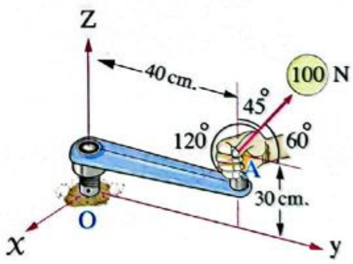


(a) $75\hat{i} + 45\hat{j} - 75\hat{k}$
(b) $75\hat{j} + 75\hat{k}$
(c) $75\hat{i} - 75\hat{j}$
(d) $-75\hat{i} + 75\hat{j} - 75\hat{k}$

31 **In the opposite figure :**

The norm of the moment of the force

100 N. about the X–axis ≃ .... newtons.cm.

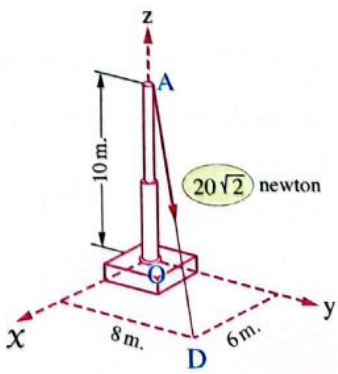


(a) 1282.43
(b) 1328.43
(c) 1420.5
(d) 1428.4

32 **In the opposite figure :**

A force of magnitude $20\sqrt{2}$ N.acts at point A in direction of $\overrightarrow{AD}$

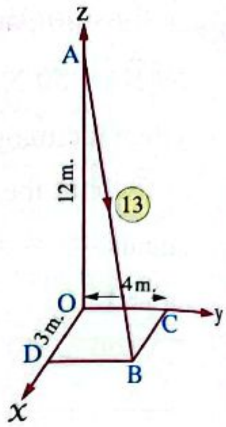
, then the moment of $\vec{F}$ about O is ....



(a) $-160\hat{i} + 120\hat{j}$
(b) $120\hat{i} + 160\hat{j}$
(c) $120\hat{i} - 160\hat{j}$
(d) $160\hat{i} - 120\hat{j}$

33 *(1st Session 2021)* **In the opposite figure :**

A flag pole of height 12 meter is pulled by a force $\vec{F}$ of magnitude 13 newton acts in the direction of $\overrightarrow{AB}$, then the moment vector of the force $\vec{F}$ about the origin point = ...



ⓐ $48\,\hat{i} + 36\,\hat{j}$

ⓑ $48\,\hat{i} - 36\,\hat{j}$

ⓒ $-48\,\hat{i} - 36\,\hat{j}$

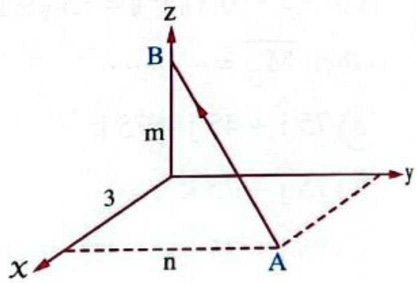
ⓓ $-48\,\hat{i} + 36\,\hat{j}$

---

34 *(Trial 2021)* **In the opposite figure :**

Force $\vec{F}$ of magnitude $10\sqrt{2}$ N. acts along $\overrightarrow{AB}$ where $\|\overrightarrow{AB}\| = 5\sqrt{2}$

If the moment vector of $\vec{F}$ about the origin is $\overrightarrow{M_O} = 40\,\hat{i} - 30\,\hat{j}$, then n + m = ...



ⓐ 7 ⓑ 8

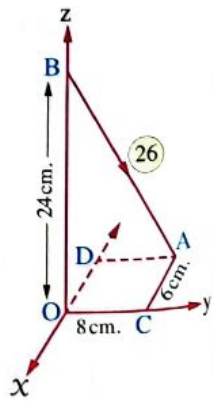
ⓒ 9 ⓓ 10

---

35 *(2nd Session 2021)* **In the opposite figure :**

B $\in$ z-axis , BO = 24 cm. , D $\in$ x-axis , C $\in$ y-axis , ACOD is a rectangle where AC = 6 cm. , CO = 8 cm. ,

A force $\vec{F}$ of magnitude 26 newton acts in the direction $\overrightarrow{BA}$, then $\overrightarrow{M_O}$ = ...

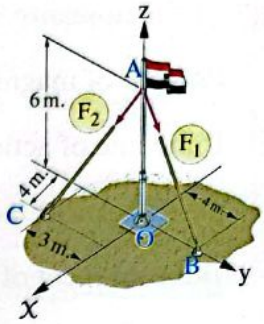


ⓐ $-192\,\hat{i} + 144\,\hat{j}$ ⓑ $192\,\hat{i} - 144\,\hat{j}$

ⓒ $-192\,\hat{i} - 144\,\hat{j}$ ⓓ $144\,\hat{i} - 192\,\hat{j}$

36 **In the opposite figure :**

The force $F_1 = 6\sqrt{13}$ newton and $F_2 = \sqrt{61}$ newton in the directions of $\overrightarrow{AB}$ and $\overrightarrow{AC}$ as shown in the figure. Then the sum of the moments of the forces about point O = ...



(a) $-54\hat{i} - 24\hat{j}$

(b) $-54\hat{i} + 24\hat{k}$

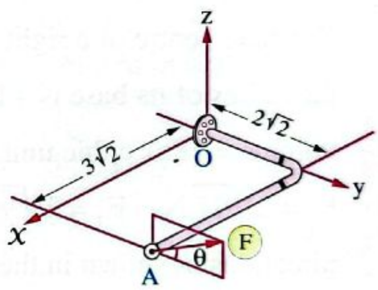
(c) $-54\hat{i} - 24\hat{k}$

(d) $-54\hat{i} + 24\hat{j}$

---

37 ***(Trial 2021)*** **In the opposite figure :**

Force $\vec{F}$ of magnitude 80 N. acts on the rod at A where $\vec{F}$ inclined on the x y-plane at an angle θ of measure 45° and the force is parallel to the y z-plane , then the moment of the force $\vec{F}$ about O = ...



(a) $80\sqrt{2}\,\hat{i} - 120\sqrt{2}\,\hat{j} - 120\sqrt{2}\,\hat{k}$

(b) $40\sqrt{2}\,\hat{i} + 120\sqrt{2}\,\hat{j} + 80\sqrt{2}\,\hat{k}$

(c) $160\,\hat{i} - 240\,\hat{j} + 240\,\hat{k}$

(d) $240\,\hat{i} - 160\,\hat{j} - 240\,\hat{k}$

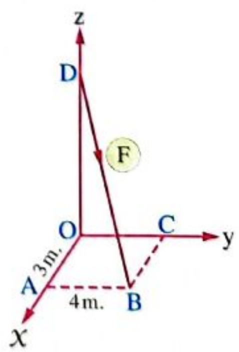
---

38 **In the opposite figure :**

If the equation of the straight line $\overleftrightarrow{BD}$ is $\frac{x-3}{3} = \frac{y-4}{4} = \frac{-z}{5}$

force $\vec{F}$ acts along $\overrightarrow{DB}$ where $\|\vec{F}\| = 15\sqrt{2}$ N.

, then the moment vector of $\vec{F}$ about (O) equals ....



(a) $60\,\hat{i} - 45\,\hat{j}$

(b) $-60\,\hat{i} + 45\,\hat{j}$

(c) $60\,\hat{i} + 45\,\hat{j}$

(d) $-60\,\hat{i} + 45\,\hat{j} - 15\,\hat{k}$

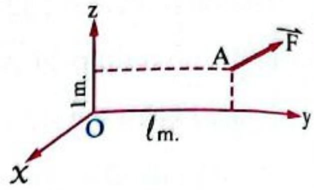
39 **In the opposite figure :**

Force $\vec{F}$ of magnitude 100 N. acts at $A \in$ plane y z

If the line of action of the force $\vec{F}$ makes with coordinate axes angles of measures 45° , 60° , 120° respectively.

If the moment of $\vec{F}$ about the x-axis equals – 150 N.m.

, then ℓ = ... m.



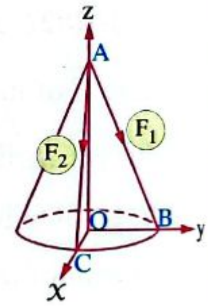
ⓐ 1 ⓑ 2

ⓒ 3 ⓓ 5

---

40 **In the opposite figure :**

The base centre of a right circular cone lies at (O) and the radius of its base is 4 length unit and its volume = 48 π cubic unit. Two forces of magnitude $F_1 = 2\sqrt{97}$ N. , $F_2 = 3\sqrt{97}$ N. act in $\overrightarrow{AB}$ and $\overrightarrow{AC}$ directions as shown in the figure , then the moment of the resultant of the two forces about (O) = ...



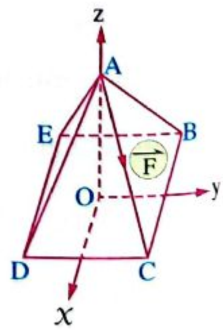
ⓐ $-72\hat{i} + 108\hat{k}$ ⓑ $-72\hat{i} + 108\hat{j}$

ⓒ $-72\hat{j} + 108\hat{k}$ ⓓ $108\hat{i} - 72\hat{k}$

---

41 **In the opposite figure :**

A uniform quadrilateral pyramid ABCDE , the centre of its base lies at (O) and $\overline{BC}$ // the x-axis and its height 6 units and its volume = 32 cubic unit. If a force of magnitude $5\sqrt{11}$ N. acts in $\overrightarrow{AC}$ direction as shown in the figure then the moment of the force $\vec{F}$ about (B) = ... moment unit.



ⓐ $60\hat{i} + 20\hat{j}$ ⓑ $20\hat{i} + 60\hat{j}$

ⓒ $60\hat{i} + 20\hat{k}$ ⓓ $60\hat{j} + 20\hat{k}$

Third Questions on parallel coplanar forces

1. $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces acting in opposite directions. $F_1 = 14$ N. , $F_2 = 10$ N. , then the magnitude of their resultant equals .... N.

   (a) 24 (b) 4 (c) 140 (d) 1.4

2. Two forces 2 F , 3 F are parallel and acting in the same direction , the magnitude of their resultant is 35 N. , then the magnitude of the smaller force in newton equals ....

   (a) 7 (b) 10 (c) 14 (d) 21

3. If $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces , $\overrightarrow{F_1} = 3\,\hat{i} + k\,\hat{j}$, $\overrightarrow{F_2} = -6\,\hat{i} + 8\,\hat{j}$, then the constant k = ...

   (a) 4 (b) $4\frac{1}{4}$ (c) -4 (d) -2

4. From the following set of forces , there are two parallel forces acting in opposite directions , they are ....

   (a) $\overrightarrow{F_1} = 2\,\hat{i} - 3\,\hat{j}$, $\overrightarrow{F_2} = 4\,\hat{i} - 6\,\hat{j}$
   (b) $\overrightarrow{F_1} = 2\,\hat{i} - 3\,\hat{j}$, $\overrightarrow{F_2} = -4\,\hat{i} + 6\,\hat{j}$
   (c) $\overrightarrow{F_1} = 2\,\hat{i} - 3\,\hat{j}$, $\overrightarrow{F_2} = 6\,\hat{i} - 4\,\hat{j}$
   (d) $\overrightarrow{F_1} = 2\,\hat{i} - 3\,\hat{j}$, $\overrightarrow{F_2} = -6\,\hat{i} + 4\,\hat{j}$

5. If $\overrightarrow{F_1} \,//\, \overrightarrow{F_2}$ and they act in opposite directions , then $\overrightarrow{R}$ = ...

   (a) $\overrightarrow{F_1} - \overrightarrow{F_2}$ (b) $\overrightarrow{F_1} + \overrightarrow{F_2}$ (c) $\overrightarrow{F_1} \times \overrightarrow{F_2}$ (d) $\overrightarrow{F_1} \cdot \overrightarrow{F_2}$

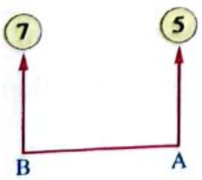
6. $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces , their resultant $\overrightarrow{R}$. If $F_1 = 8$ N , R = 11 N. , then F_2 = ... N.

   (a) 3 only (b) 19 only (c) 16 or 22 (d) 3 or 19

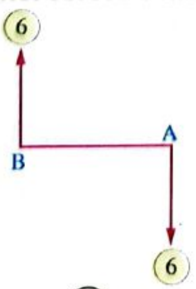
7. If $\overrightarrow{F_1} \,//\, \overrightarrow{F_2}$, $F_1 = 5$ N , R = 3 N , then $F_2 \in$ ....

   (a) {2} (b) {8} (c) {2 , 8} (d) {3 , 5}

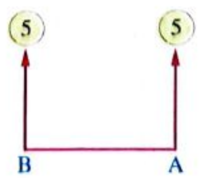
8. In which pair of parallel forces , their resultant acts at the midpoint of $\overline{AB}$



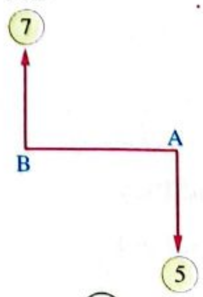
(a)



(b)



(c)



(d)

9 If three coplanar forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$, $\overrightarrow{F_3}$ are in equilibrium and $\overrightarrow{F_1} \,//\, \overrightarrow{F_2}$ and act in the same direction then ....

(a) $\overrightarrow{F_3}$ is perpendicular to each $\overrightarrow{F_1}$, $\overrightarrow{F_2}$

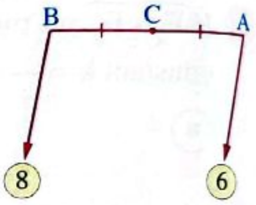
(b) $\overrightarrow{F_3}$ is parallel to each $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ and in the same direction.

(c) $\overrightarrow{F_3}$ is parallel to each $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ but in the opposite direction.

(d) $\overrightarrow{F_3} = \overrightarrow{F_1} + \overrightarrow{F_2}$

---

10 **In the opposite figure :**



F_1 , F_2 are two parallel forces act at two points A and B

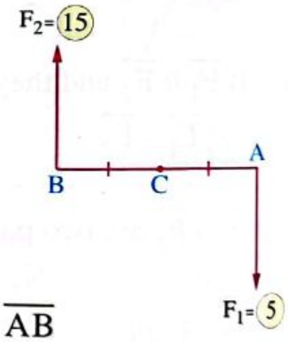
If C is the midpoint of $\overline{AB}$, then their resultant acts at point $D \in \overleftrightarrow{AB}$ where ....

(a) $D \in \overline{AC}$ (b) $D \in \overline{BC}$

(c) D coincides to C (d) $D \in \overrightarrow{AB}$, $D \notin \overline{AB}$

---

11 **In the opposite figure :**



F_1 , F_2 are two parallel forces acting at two points A , B

If C is the midpoint of $\overline{AB}$, then their resultant acts at $D \in \overleftrightarrow{AB}$ where ....

(a) $D \in \overline{AC}$ (b) $D \in \overline{BC}$

(c) D coincides to C (d) $D \in \overrightarrow{AB}$, $D \notin \overline{AB}$

---

12 Two parallel forces of magnitude F_1 , F_2 act in the same direction and the magnitude of their resultant R , then R ....

(a) more than F_1 (b) less than F_2

(c) equals $F_1 - F_2$ (d) equals $F_2 - F_1$

---

13 If $F_1 = 30$ N. , $F_2 = 70$ N. the distance between $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ equals 100 cm. where $\overrightarrow{F_1} \,//\, \overrightarrow{F_2}$ and they act in opposite directions , then the distance between the point of action of their resultant from $\overrightarrow{F_1}$ = ... cm.

(a) 75 (b) 25 (c) 175 (d) 70

14 Two parallel forces act in opposite directions their magnitudes are 10 , 16 N. If their resultant at a distance 24 cm. from the line of action of the smaller force , then the distance between the line of action of the two forces = ... cm.

(a) 12 (b) 18 (c) 9 (d) 18

---

15 Two parallel forces , $F_1 = 10$ N , $F_2 = 2$ N. act at A , B respectively such that AB = 120 cm. , then the magnitude and direction of their resultant $\overrightarrow{R}$ could be ....

(a) R = 12 N , act at $M \in \overline{AB}$ where AM = 20 cm. opposite to $\overrightarrow{F_2}$ direction.

(b) R = 12 N , acts at $M \in \overline{AM}$ where AM = 20 cm. , and in $\overrightarrow{F_1}$ direction.

(c) R = 8 N , acts at $M \notin \overline{AB}$, $M \in \overrightarrow{AB}$ where AM = 3 cm. , and in $\overrightarrow{F_1}$ direction.

(d) R = 8 N , acts at $M \notin \overline{AB}$, $M \in \overrightarrow{AB}$ where AM = 30 cm. , and in $\overrightarrow{F_1}$ direction.

---

16 Two parallel forces act in the same direction their magnitudes are F , 3 F and act at two points A , B respectively where AB = 60 cm. , then their resultant acts at $C \in \overleftrightarrow{AB}$ where AC = ... cm.

(a) 36 (b) 40 (c) 45 (d) 50

---

17 If $\overrightarrow{R}$ is the resultant of two parallel forces $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$ and $F_1 < R < F_2$, then ....

(a) $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ act in the same direction.

(b) $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ act in opposite directions.

(c) $\overrightarrow{R}$ acts in $\overrightarrow{F_1}$ direction.

(d) $\overrightarrow{R} = \overrightarrow{F_1} - \overrightarrow{F_2}$

---

18 If $\overrightarrow{R}$ is resultant of two parallel forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$, and $F_1 < F_2 < R$, then ....

(a) $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ act in the same direction.

(b) $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ act in opposite directions.

(c) $R = F_1 - F_2$

(d) The line of action of $\overrightarrow{R}$ is closer to $\overrightarrow{F_1}$ than $\overrightarrow{F_2}$

---

19 If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$ and act at two points A , B respectively their resultant $\overrightarrow{R}$ acts at $M \in \overleftrightarrow{AB}$ and AM = 2 MB , $B \notin \overline{AM}$, then ....

(a) $R = F_1 + F_2$

(b) $R = F_1 - F_2$

(c) $R = F_2 - F_1$

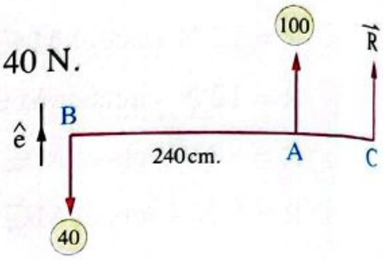
(d) The magnitude of R can not be determined

20 $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces, the distance between their lines of action = 10 cm. , and the line of action of their resultant at a distance 12 cm. from the line of action of $\overrightarrow{F_1}$, then ....

(a) $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ act in the same direction.
(b) $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ act in opposite directions.
(c) $\overrightarrow{R} = \overrightarrow{F_1} - \overrightarrow{F_2}$
(d) $R = F_1 + F_2$

---

21 **In the opposite figure :**



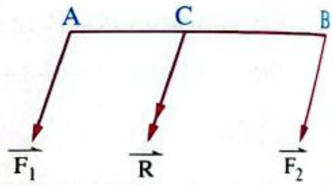
$\overrightarrow{R}$ is the resultant of two parallel forces of magnitude 100 N. , 40 N.

If AB = 240 cm. , then AC equals ....

(a) 100 cm.
(b) 120 cm.
(c) 160 cm.
(d) 200 cm.

---

22 **In the given figure :**



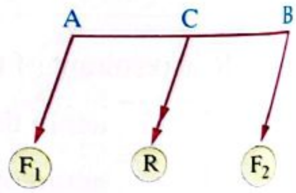
$\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces in the same direction and act at the points A and B respectively , their resultant is $\overrightarrow{R}$ acts at the point $C \in \overline{AB}$

If F_1 = 8 newton , R = 13 newton and AC = 10 cm. , then AB = ... cm.

(a) 16
(b) 13
(c) 26
(d) 6

---

23 **In the given figure :**

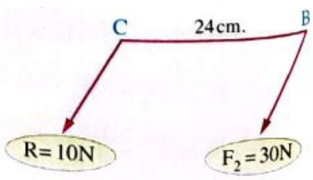


$\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two like parallel forces acting at A and B respectively , their resultant is $\overrightarrow{R}$ and acting at point $C \in \overline{AB}$. If F_2 = 6 newton , AC = 24 cm. and AB = 56 cm. , then ....

(a) F_1 = 8 newton , R = 14 newton
(b) F_1 = 24 newton , R = 32 newton
(c) F_1 = 32 newton , R = 38 newton
(d) F_1 = 8 newton , R = 2 newton

---

24 **In the opposite figure :**



If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$ and act at A , B respectively such that $A \in \overleftrightarrow{BC}$, BC = 24 cm. , then AB = ... cm.

(a) 6
(b) 12
(c) 18
(d) 48

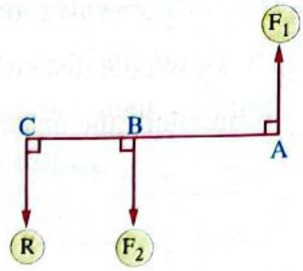
25 **In the opposite figure :**

$\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces act at the two points A , B

If their resultant acts at the point C , where $C \in \overrightarrow{AB}$

, AB : AC = 4 : 7 and the magnitude of their resultant

is 20 gm.wt. , then F_1 = ... gm.wt.



(a) 35 (b) 20 (c) 25 (d) 15

---

26 If $\overrightarrow{R}$ is the resultant of two parallel forces of magnitude 30 , F , R = 10 N. , then could be ....

(a) F = 20 N. and acts in the opposite direction of the force of magnitude 30 N.

(b) F = 20 N. and acts in the same direction of the force of magnitude 30 N.

(c) F = 40 N. and acts in the opposite direction of the resultant.

(d) F = 40 N. and acts in the same direction as the force of magnitude 30 N.

---

27 Two parallel forces of magnitudes F_1 , F_2 acting in the same direction , the magnitude of their resultant is 25 N. and acts at a point 4 cm. away from the first force and 6 cm. away from the second force, then $F_1 - F_2$ = ... N.

(a) 20 (b) 15 (c) 10 (d) 5

---

28 $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces act in opposite directions and the line of action of their resultant far from the line of action of the first force 9 cm. and from the second 12 cm. If the magnitude of their resultant is 14 N. , then $F_1 + F_2$ = ... N.

(a) 14 (b) 49 (c) 98 (d) 104

---

29 $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two forces , the magnitude of the first force is 4 kg.wt. and their resultant $(\overrightarrow{R})$ = 6 kg.wt. the distance between $\overrightarrow{F_1}$ and $\overrightarrow{R}$ equals 8 cm. If $\overrightarrow{F_1}$ and $\overrightarrow{R}$ are acting in the same direction , then the distance between $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ equals .... cm.

(a) 12 (b) 16 (c) 20 (d) 24

30 $\vec{F_1}$, $\vec{F_2}$ are two forces , the magnitude of the first is 4 kg.wt. and their resultant ($\vec{R}$) is 6 kg.wt. the distance between $\vec{F_1}$ and $\vec{R}$ equals 8 cm. If $\vec{F_1}$ and $\vec{R}$ are acting in opposite directions the distance between $\vec{F_1}$, $\vec{F_2}$ equals .... cm.

(a) 3.2 (b) 4.8 (c) 9.6 (d) 12.6

---

31 If $\vec{F_1}$, $\vec{F_2}$ are two parallel forces acting in the same direction. The distance between them is 60 cm. The magnitude of their resultant $\vec{R}$ = 30 newtons. and acts 20 cm. from $\vec{F_1}$, then F_1 = ... newton.

(a) 10 (b) 15 (c) 20 (d) 25

---

32 If $\vec{F_1}$, $\vec{F_2}$ are two parallel forces acting at two points A , B where F_1 = 30 kg.wt. , $F_1 > F_2$ and their resultant R has magnitude 10 kg.wt. and acting at point C where BC = 90 cm. , then AB = ... cm.

(a) 30 (b) 45 (c) 60 (d) 120

---

33 Two parallel forces of magnitude 15 , F N. If the magnitude of their resultant is 25 newtons , the known force and the resultant are acting in the same direction , then the magnitude of $\vec{F}$ (in newton) equals ....

(a) 10 (b) 20 (c) 30 (d) 40

---

34 Two parallel forces of magnitude 15 , F N. If the magnitude of their resultant is 25 N. The known force and the resultant are acting in opposite directions , then the magnitude of $\vec{F}$ (in newton) equals ....

(a) 10 (b) 20 (c) 30 (d) 40

---

35 Two parallel forces of magnitude 20 , F newtons. The magnitude of their resultant is 35 netwons. The distance between the line of action of the known force and the resultant equals 15 cm. The known force and the resultant are acting in the same directions , then the distance between the line of action of F and line of action of the resultant equals ....

(a) 5 cm. (b) 10 cm. (c) 20 cm. (d) 35 cm.

36 Two parallel forces of magnitude 20 , F newtons. The magnitude of their resultant is 35 netwons. The distance between the line of action of the known force and the resultant equals 15 cm. the known force and the resultant are acting in opposite directions then the distance between the point of action of F and point of action of the resultant equals .... cm.

(a) $\frac{225}{11}$ (b) $\frac{160}{11}$ (c) $\frac{105}{11}$ (d) $\frac{60}{11}$

---

37 If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$ and their resultant $\overrightarrow{R}$ such that : $\overrightarrow{F_2} = -9\hat{i} + 12\hat{j}$, $\overrightarrow{R} = -2\overrightarrow{F_1}$, then $\overrightarrow{F_1} =$ ....

(a) $-15\hat{i} + 20\hat{j}$ (b) $-3\hat{i} + 4\hat{j}$ (c) $3\hat{i} - 4\hat{j}$ (d) $15\hat{i} - 20\hat{j}$

---

38 Two parallel forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ and $\overrightarrow{F_1} = 2\hat{i} - 6\hat{j}$, $\|\overrightarrow{F_2}\| = 6\sqrt{10}$ N.
, then $\overrightarrow{F_2}$ could be ....

(a) $6\hat{i} - 18\hat{j}$ (b) $6\hat{i} + 18\hat{j}$ (c) $-6\hat{i} - 18\hat{j}$ (d) $4\hat{i} - 12\hat{j}$

---

39 If $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two forces such that $3\overrightarrow{F_1} = 2\overrightarrow{F_2}$ and their resultant at a distance 15 cm. from $\overrightarrow{F_1}$, then the distance between the resultant and $\overrightarrow{F_2} =$ .... cm.

(a) 8 (b) 10 (c) 12 (d) 25

---

40 If $\overrightarrow{F_1}$ acts at point A , $\overrightarrow{F_2}$ acts at point B , $\overrightarrow{F_2} + 3\overrightarrow{F_1} = \overrightarrow{O}$ and their resultant acts at point C where $C \in \overleftrightarrow{AB}$, then AB + AC = ...

(a) 3 BC (b) 4 BC (c) 5 BC (d) 6 BC

---

41 If F_1 , F_2 are two forces act at two points A , B respectively where $5\overrightarrow{F_1} = 7\overrightarrow{F_2}$ and their resultant acts at point C where $C \in \overleftrightarrow{AB}$, then ....

(a) AC : CB = 5 : 7 (b) AC : CB = 7 : 5
(c) AC : AB = 7 : 12 (d) AB : CB = 12 : 5

---

42 If $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two forces acting at two points A , B respectively where $2\overrightarrow{F_1} = -3\overrightarrow{F_2}$ and their resultant acts at point $C \in \overleftrightarrow{AB}$, then ....

(a) AC : CB = 2 : 1 (b) AC : AB = 2 : 3
(c) BC : AC = 3 : 2 (d) BC : AB = 3 : 2

43 If the magnitudes of two parallel forces acting in the same direction are $\frac{x}{y}$, $\frac{y}{x}$ N. and their resultant 2 N. , then ....

(a) $x = y$ (b) $x = 2y$ (c) $y = 2x$ (d) $x = \frac{1}{2}y$

44 F_1 , F_2 are magnitude of two parallel forces acting in the same direction , if you switched their places , their resultant does not change its position , then ....

(a) $F_1 = F_2$ (b) $F_1 = 2F_2$ (c) $2F_1 = F_2$ (d) $F_1 = \frac{1}{2}F_2$

45 $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces act in the same direction they are acting at A and B respectively and their resultant acts at $C \in \overline{AB}$. If the magnitude of $\overrightarrow{F_1}$ increases , then ....

(a) the magnitude of the resultant increases and its point of action moves towards B

(b) the magnitude of the resultant increases and its point of action moves towards A

(c) the magnitude of the resultant does not increases and its point of action moves towards B

(d) the magnitude of the resultant does not increase and its point of action moves towards A

46 $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces act in the same direction they are acting at A and B respectively and $F_1 > F_2$ If the magnitude of each has doubled , then ....

(a) the resultant has doubled but its point of action does not change.

(b) the resultant has doubled and its point of action moves towards $\overrightarrow{F_1}$

(c) the resultant has doubled and its point of action moves towards $\overrightarrow{F_2}$

(d) the resultant has not doubled and its point of action does not change.

47 If two parallel forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ act at two points A , B respectively and their resultant acts at point $C \in \overleftrightarrow{AB}$. If the two forces $\overrightarrow{F_2}$, $\overrightarrow{F_3}$ act at the two points A and B respectively , their resultant acts at C also , then ....

(a) $F_1 = F_2 = F_3$ (b) $F_1 + F_3 = 2F_2$

(c) $F_1 \times F_3 = F_2^2$ (d) $\frac{1}{F_1} + \frac{1}{F_3} = \frac{2}{F_2}$

48 If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$ are acting at two points A , B respectively and their resultant $\overrightarrow{R}$ acts at point $M \in \overleftrightarrow{AB}$ and $F_1 > F_2$, $F_2 = R$, then which of the following statements is not true ?

(a) $R = \frac{1}{2} F_1$
(b) $R = F_1 - F_2$
(c) $BM = 2\, AB$
(d) $AM = MB$

---

49 If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$ act at two points A , B respectively their resultant $\overrightarrow{R}$ acts at $C \in \overleftrightarrow{AB}$ and $F_2 > R > F_1$, then ....

(a) $AC \geq 2\, AB$
(b) $AC > 2\, BC$
(c) $AC > 2\, AB$
(d) $BC = \frac{1}{2} AB + AC$

---

50 If $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces where $\overrightarrow{F_1} = 3\,\hat{i} - 4\,\hat{j}$, $\overrightarrow{F_2} = -6\,\hat{i} + 8\,\hat{j}$. They are acting at A (1 , 0) , B (6 , 0) respectively , then the point of intersection of their resultant with $\overleftrightarrow{AB}$ is ....

(a) (8 , 0)
(b) (9 , 0)
(c) (10 , 0)
(d) (11 , 0)

---

51 If $\overrightarrow{F_1} = -2\,\hat{i} + \hat{j}$ acts at A (– 2 , 0) , $\overrightarrow{F_2} \parallel \overrightarrow{F_1}$ where $\overrightarrow{R} = 6\,\hat{i} - 3\,\hat{j}$ acts at C (6 , 0) , then the intersection point between the line of action of $\overrightarrow{F_2}$ and $\overleftrightarrow{AC}$ is ....

(a) (4 , 0)
(b) (8 , 0)
(c) (2 , 0)
(d) (0 , 0)

---

52 $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces act in the same direction at two points , A (–1 , 3) and B (3 , 7) respectively. If the line of action of their resultant intersects $\overline{AB}$ at C (0 , 4) , then $\frac{F_1}{F_2}$ = ...

(a) $\frac{1}{4}$
(b) $\frac{1}{3}$
(c) $\frac{3}{4}$
(d) $\frac{3}{1}$

---

53 Two parallel forces have same direction , the magnitude of the two forces 5 N. , 8 N. and act at A and B respectively where AB = 39 cm. If another force of magnitude F is added to the first force and in the same direction and the resultant moves 8 units , then the magnitude of F = ... N.

(a) 6.5
(b) 8
(c) 9.5
(d) 13

54 Two parallel forces acting in the same direction, their magnitudes are F , 3 F and acting at two points A , B respectively. If the two forces switched their places , then their resultant moves a distance equals .... length unit.

(a) $\frac{3}{4}$ AB (b) $\frac{1}{2}$ AB (c) $\frac{1}{3}$ AB (d) $\frac{1}{4}$ AB

55 If $\overrightarrow{F_1} // \overrightarrow{F_2}$, $F_1 > F_2$ and the magnitude of their resultant = R if they are acting in opposite directions , and the magnitude of their resultant = 5 R if they have the same direction , then F_1 = ... F_2

(a) $\frac{4}{3}$ (b) $\frac{3}{2}$ (c) $\frac{5}{3}$ (d) $\frac{7}{3}$

56 The magnitude of two parallel forces are 3 F , 2 F act in the same direction act at two points A , B respectively. If the force 3 $\overrightarrow{F}$ has been translated parallel to itself in $\overrightarrow{AB}$ direction 15 cm. , then the resultant moves .... cm.

(a) 9 (b) 25 (c) 6 (d) 37.5

57 Two parallel forces in the same direction of magnitudes 3 N. and 2 N. act at the points A and B respectively where AB = 5 unit of length. The force 3 N. is translated in direction of $\overrightarrow{BA}$ 3 units of length and the force 2 is translated in direction of $\overrightarrow{AB}$ two units of length , then the resultant is translated in direction .... distance .... length unit.

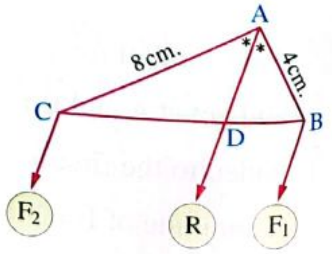
(a) $\overrightarrow{AB}$, 1 (b) $\overrightarrow{BA}$, 1 (c) $\overrightarrow{AB}$, 2 (d) $\overrightarrow{BA}$, 2

58 $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces act in the same direction. If $\overrightarrow{F_1}$ has been moved a distance of x parallel to itself , then their resultant moves .... length unit.

(a) $\frac{F_1 x}{F_1 + F_2}$ (b) $\frac{F_1 x}{F_1 - F_2}$ (c) $\frac{F_1 x}{F_1 + 2 F_2}$ (d) $\frac{F_1 x}{F_1 - 2 F_2}$

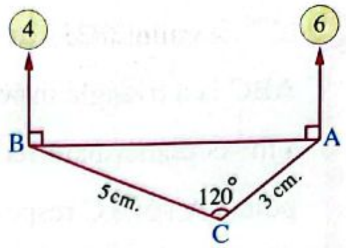
59 **In the given figure :**

If $\overrightarrow{AD}$ bisects ∠ A and F_1 , F_2 are two parallel forces acting at B and C. Their resultant acts at D , then F_1 = ...



(a) F_2 (b) $\frac{1}{2}$ F_2 (c) 2 F_2 (d) $\frac{1}{3}$ F_2

60 **In the opposite figure :**

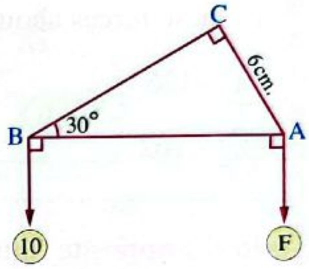


Two forces of magnitude 6 N. and 4 N. act at A and B perpendicular to $\overline{AB}$ and in the same direction then the line of action of their resultant is at a distance .... cm. from A.

(a) 1.6 (b) 1.8 (c) 2.4 (d) 2.8

---

61 **In the opposite figure :**



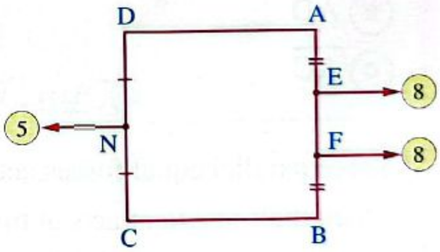
Two forces of magnitude FN. and 10 N. act at A and B perpendicular to $\overline{AB}$. If the line of action of their resultant passes through the intersection point of its medians , then F = ... N.

(a) 10 (b) 12

(c) 14 (d) 15

---

62 ***(Trial 2021)*** **In the opposite figure :**

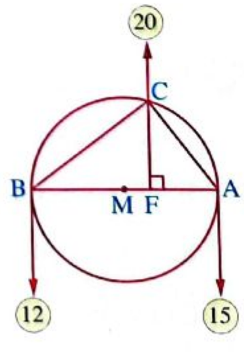


ABCD is a square. Parallel forces of magnitude 8 N. , 8 N. , 5 N. act at the points E , F , N respectively where N is the midpoint of $\overline{DC}$, AE = FB , then the algebraic measure of the sum of the moments of the forces about the intersection point of the diagonals = ... N.cm.

(a) 16 (b) 8 (c) 5 (d) zero

---

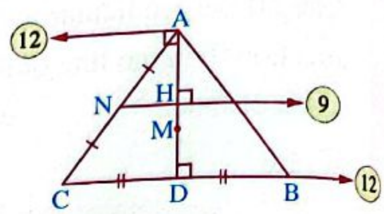
63 ***(1st Session 2021)*** **In the opposite figure :**



The coplanar parallel forces 20 , 15 , 12 newton act at the points C , A , B respectively in directions perpendicular to the diameter $\overline{AB}$ in the circle M , if AC = 6 cm. , CB = 8 cm. , then the sum of the algebraic measure of the moments of these forces about the center of the circle (M) equals .... newton. cm.

(a) – 13 (b) 43 (c) 13 (d) – 43

64 ***(2nd Session 2021)*** **In the opposite figure :**



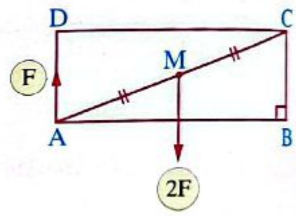
ABC is a triangle in which AB = AC = 15 cm. , BC = 18 cm. , the coplanar parallel forces 12 , 9 , 12 newton act at the points A , N , C respectively and perpendicular to $\overline{AD}$, if M is the point of intersection of the medians of triangle ABC , then the sum of the algebraic measures of moments of these forces about the point M = ... newton. cm.

ⓐ −126 ⓑ 162

ⓑ − 162 ⓓ 126

---

65 **In the opposite figure :**



ABCD is a rectangle. F , 2 F are two parallel forces act as shown in the figure, then the line of action of resultant is ....

ⓐ $\overleftrightarrow{AD}$ ⓑ $\overleftrightarrow{CB}$

ⓒ $\overleftrightarrow{AC}$ ⓓ $\overleftrightarrow{DC}$

---

66 Three parallel equal forces acting at the vertices of triangle ABC and have same direction , then their resultant acts at the point which is ....

ⓐ the centre of the circumcircle of the triangle.

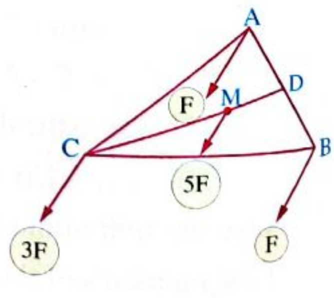
ⓑ the intersection of the medians of the triangle.

ⓒ the intersection of the heights

ⓓ the intersection of the 3 angle bisectors of the triangle.

---

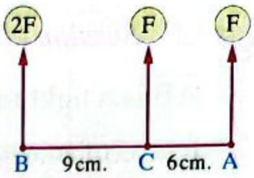
67 **In the opposite figure :**



ABC is a triangle , M is the point of concurrent of its medians F , F , 5 F , 3 F are parallel forces act in the same direction and their lines of action lie on the triangle plane , the median length $\overline{CD}$ = 30 cm. , then the resultant of these forces acts at a point at a distance .... cm. from C.

ⓐ 14 ⓑ 15 ⓒ 16 ⓓ 20

68 The resultant of the parallel forces in the opposite figure acts at $D \in \overline{AB}$ where ....

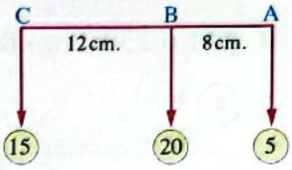


(a) D coincides with C (b) DA = 9 cm.

(b) DB = 7 cm. (d) DC = 1 cm.

---

69 **In the opposite figure :**

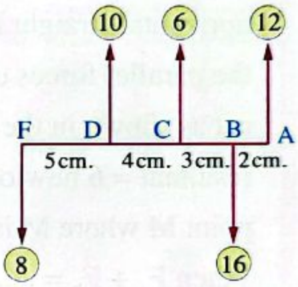


Three parallel forces their resultant at a distance .... cm. from A.

(a) 11.5 (b) 8.5 (c) 31.5 (d) 28.5

---

70 ***(Trial 2021)* In the opposite figure :**



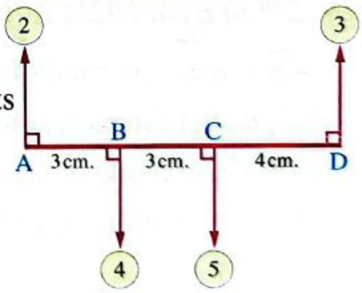
$\overline{AF}$ is a light rod. Parallel forces act on it as shown in the figure and the line of action of their resultant intersect $\overline{AF}$ at point E , then ....

(a) $E \in \overline{AC}$ (b) $E \in \overline{CF}$

(c) $E \in \overrightarrow{FA}$, $E \notin \overline{FA}$ (d) $E \in \overrightarrow{AF}$, $E \notin \overline{AF}$

---

71 ***(1st Session 2021)* In the opposite figure :**



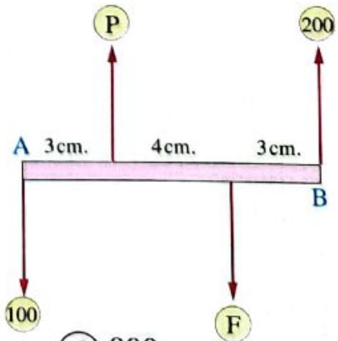
The forces of magnitudes 2 , 4 , 5 and 3 newton act at the points A , B , C and D respectively , where CD = 4 cm. , BC = AB = 3 cm. If their resultant acts at the point M where $M \in \overline{AD}$, then DM = ... cm.

(a) 3 (b) 7 (c) 4 (d) 3.5

---

72 The opposite figure shows a light rod $\overline{AB}$ parallel forces act on it as shown the magnitude of the resultant is 300 N. and acts upward and its point of action on the rod at a distance 4 cm. from A.

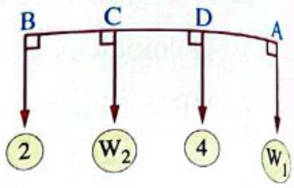
, then F + P = ... N.



(a) 350 (b) 550 (c) 750 (d) 900

73 ***(2nd Session 2021)*** **In the opposite figure :**

$\overline{AB}$ is a light ruler of negligible weight and of length 300 cm. , forces of magnitudes W_1 , 4 , W_2 and 2 gm.wt. act in a direction perpendicular to $\overline{AB}$ where AD = DC = CB. If the magnitude of their resultant = 10 gm.wt. and acts at the point M where AM = 130 cm. , then $W_1 - W_2 =$ .... gm.wt.

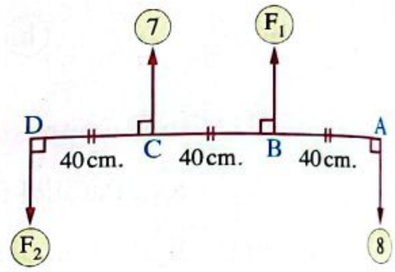


(a) 1 (b) 2 (c) 3.5 (d) 4

---

74 ***(1st Session 2021)*** **In the opposite figure :**

A , B , C , and D are four points lying on the same horizontal straight line such that AB = BC = CD = 40 cm. the parallel forces of magnitudes 8 , F_1 , 7 and F_2 newton act as shown in the figure. If the magnitude of their resultant = 6 newton and acts vertically downward at the point M where M is the midpoint of $\overline{AD}$, then $F_1 + F_2 =$ .... newton.

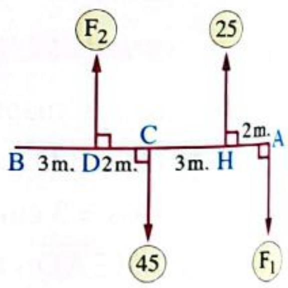


(a) 12 (b) 10 (c) 13 (d) 16

---

75 ***(2nd Session 2021)*** **In the opposite figure :**

$\overline{AB}$ is a uniform rod of length 10 m. and weight 45 kg.wt. a system of parallel forces act on the rod as shown in the opposite figure. If the magnitude of their resultant = 50 kg.wt. and acts vertically downward at the point M where $M \in \overline{AB}$ where AM = 0.7 m. , then $F_1 : F_2 =$ ....

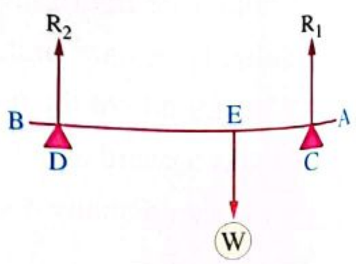


(a) 5 : 2 (b) 2 : 5 (c) 4 : 9 (d) 9 : 4

---

76 **In the opposite figure :**

If the system of forces is in equilibrium where DE = 2 EC , then each of the following is true except ....



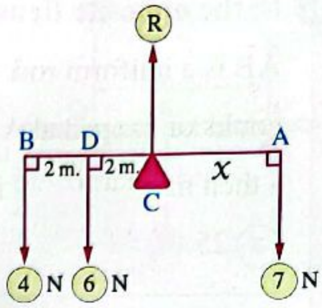
(a) $R_1 > R_2$ (b) $R_2 > R_1$

(c) $R_1 \times CE = R_2 \times DE$ (d) $\overrightarrow{R_1} + \overrightarrow{R_2} + \overrightarrow{W} = \overrightarrow{zero}$

77 **In the opposite figure :**

$\overline{AB}$ is a ruler and the forces are in equilibrium

, then x = ... m.



(a) 4

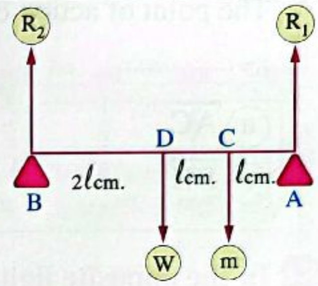
(b) 5

(c) 6

(d) 8

78 **In the opposite figure :**

The rod is in equilibrium under action of the given forces (newton) , then $R_1 - R_2$ = ... N.



(a) $\frac{1}{2}$ W + $\frac{1}{3}$ m

(b) $\frac{2}{3}$ W – m

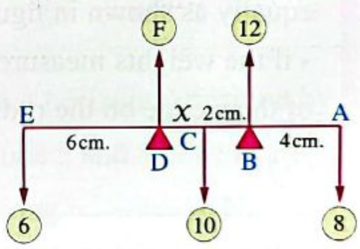
(c) $\frac{1}{2}$ m

(d) $\frac{m + W}{2}$

79 **In the opposite figure :**

If the rod is in equilibrium

, then x = ... cm.



(a) 8

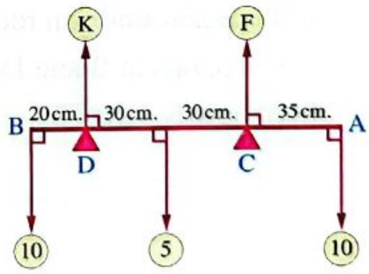
(b) 6

(c) 4

(d) 2

80 **In the opposite figure :**

If the rod is light and in horizontal equilibrium , then ....



(a) F = 15 newton , K = 10 newton

(b) F = 10 newton , K = 15 newton

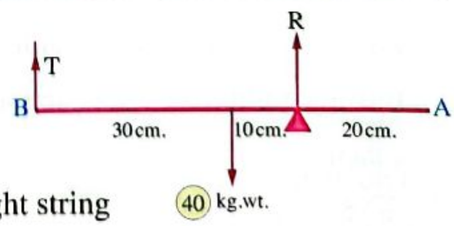
(c) F = 10 newton , K = 10 newton

(d) F = 12.5 newton , K = 12.5 newton

81 **In the opposite figure :**

$\overline{AB}$ is a uniform rod of weight 40 kg.wt. and length 60 cm. If the rod rests horizontally on a support at a distance 20 cm. from A and its end B is hanged by a light string

, then : R – T = ... kg. wt.



(a) 10

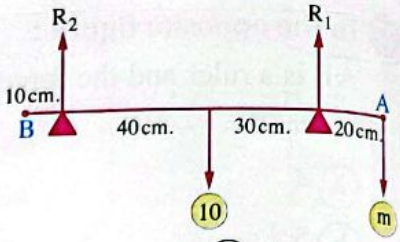
(b) 30

(c) 40

(d) 20

82 **In the opposite figure :**

$\overline{AB}$ is a uniform rod. Its weight 10 N. The greatest weight could be hanged at A without disturbing the equilibrium is m , then m = ... newton.

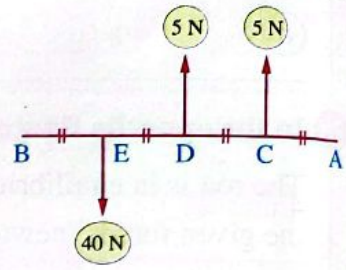


(a) 25 (b) 20 (c) 15 (d) 5

---

83 **In the opposite figure :**

The point of action of the resultant belongs to ....

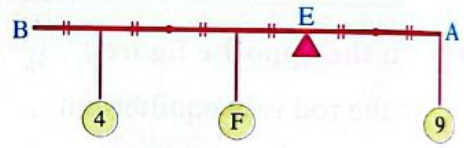


(a) $\overline{AC}$ (b) $\overline{CD}$
(c) $\overline{DE}$ (d) $\overline{EB}$

---

84 **In the opposite figure :**

If $\overline{AB}$ is a rod of negligible weight , the rod is divided equally as shown in figure and equilibrated horizontally , if the weights measured in newton , then the reaction of the wedge on the rod = ... newton.

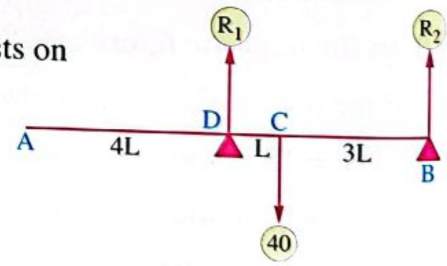


(a) 6 (b) 16 (c) 18 (d) 19

---

85 ***(1st Session 2021)*** **In the opposite figure :**

$\overline{AB}$ is a non-uniform rod of weight 40 kg.wt. acts at C rests on two supports at B and D. If the rod equilibrated horizontally , then $R_1 - R_2 =$ .... kg.wt.



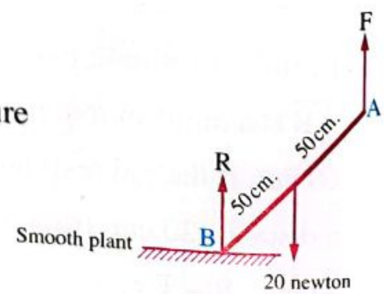
(a) 20 (b) 10
(c) 25 (d) 30

---

86 **In the opposite figure :**

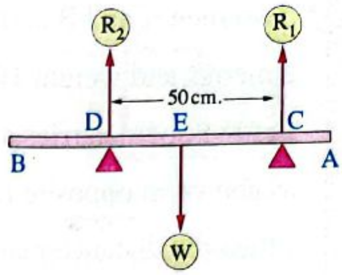
$\overline{AB}$ is a uniform rod rests at its end B on a smooth plane.

It is in equilibrium under action of the forces shown in the figure , then : F = ... N.



(a) 5 (b) 10
(c) 15 (d) 20

87 **In the opposite figure :**



$\overline{AB}$ is a uniform rod of length 100 cm. , CD = 50 cm.

, then AC = ... cm.

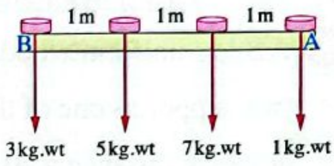
to make the reaction at C = $\frac{1}{4}$ the reaction at D

(a) 12.5 (b) 37.5

(c) 10 (d) 40

---

88 **In the opposite figure :**



4 masses are 1 , 7 , 5 , 3 kg.wt. are placed on a light rod as shown , then the point of suspension which keeps the rod horizontal is far from A distance .... m.

(a) $1\frac{3}{8}$ (b) $1\frac{5}{8}$

(c) $1\frac{7}{8}$ (d) 2

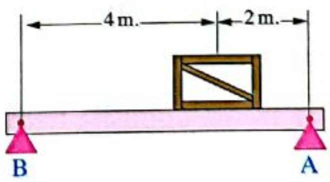
---

89 A rod of length 120 cm. and of negligible weight is suspended in a horizontal position by means of two vertical strings at its ends. Two weights of magnitude 5 and 8 newton are suspended at its points of trisections , then the tension in each string = ... N.

(a) 5 , 6 (b) 6 , 7 (c) 6 , 8 (d) 7 , 9

---

90 The opposite figure shows a uniform wooden board of mass 30 kg. for each metre of its length. If it rests horizontally on two supports A and B and carries a box of mass 240 kg. , then the pressure exerted on support A equals .... kg.wt.



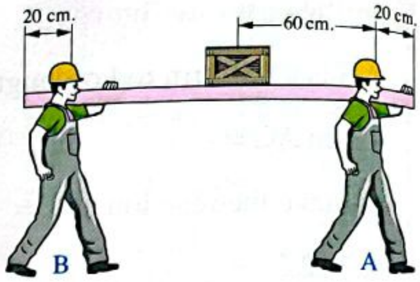
(a) 270 (b) 170 (c) 250 (d) 420

---

91 Two men carrying a uniform rod of length 16 m. and its weight 80 N. If one of the two men is carrying the rod from a point 2 m. far from one end and the other man is carrying the rod from a point 4 m. far from the other end , then the reactions of the two men on the rod are .... N.

(a) 35 , 45 (b) 32 , 48 (c) 36 , 44 (d) 34 , 46

92 Two men A and B carry a wooden board of length 2 metres and weight 16 kg.wt. acts at its midpoint and the board carries a box of weight 24 kg.wt. as shown in opposite figure.



, then the distance man B should move to equilibrate the two pressures is .... cm.

(a) 18 (b) 20 (c) 24 (d) 36

---

93 $\overline{AB}$ is a uniform wooden board of mass 10 kg. and length 4 metres. It rests horizontally on two supports, one of them at A and the other at a point distant 1 metre from B . Determine at which distance a 50 kg.wt. child can stand on the board in order to make the reactions on the two supports are equal ?

(a) At 1.4 m from A (b) At 1.4 m from B

(c) At 1.8 m from A (d) At 1.8 m from B

---

94 $\overline{AB}$ is a uniform rod of length 90 cm. and weight 60 newtons suspended horizontally by two vertical strings at its two ends A and B. Where should a weight of a magnitude 150 newton be suspended in order to make the tension magnitude at A is twice its magnitude at B ?

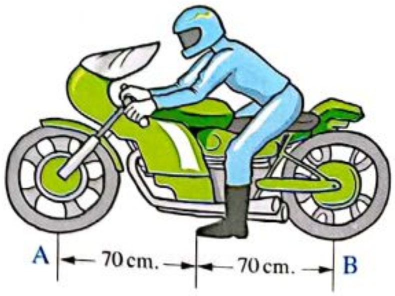
(a) 24 cm. from A (b) 24 cm. from B

(c) 48 cm. from A (d) 48 cm. from B

---

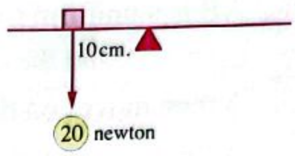
95 **In the opposite figure :**

A motorcycle of mass 200 kg. and its weight acts at the vertical line passing through the midpoint between the centres of the two wheels and if the mass of the motorcyclist is 84 kg. and its weight acts on the vertical line distant 1 meter behind the centre of the front wheel , then the reaction of the ground on each of the two wheels = ... kg.wt.



(a) 100 , 124 (b) 100 , 160 (c) 124 , 160 (d) 160 , 180

96 **In the opposite figure :**



A uniform rod rests on a support at its middle , a body is placed on it as shown in the figure. Which of the following forces cause equilibrium to the rod ?

(a) Force of magnitude 10 N. up , acting 20 cm. to the right to the middle of the rod.

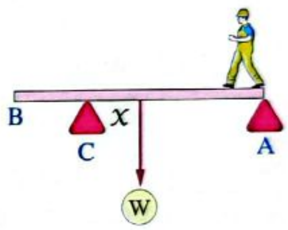
(b) Force of magnitude 10 N. down , acting 20 cm. to the right to the middle of the rod.

(c) Force of magnitude 30 N. down , acting 5 cm. to the left to the middle of the rod.

(d) Force of magnitude 30 N. up , acting 5 cm. to the left to the middle of the rod.

---

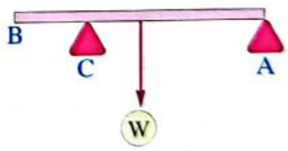
97 $\overline{AB}$ is a uniform rod of weight (W) rests horizontally on two supports , one of them at A and the other at C at a distance x from the centre of the rod. A man of weight (2 W) moves from A towards B , then the maximum distance the man can move on the rod after C without disturbing the balance of the rod = ...



(a) x (b) $\frac{1}{2}x$ (c) $\frac{1}{3}x$ (d) $2x$

---

98 **In the opposite figure :**

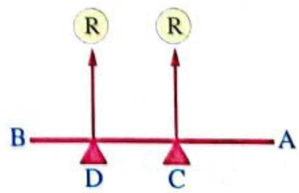


$\overline{AB}$ is a uniform rod of weight (W) rests horizontally on two supports one at A and the other at C where AC = $\frac{3}{4}$ of the rod length , then the weight should be hanged at B to make the rod about to rotate is ....

(a) $\frac{1}{2}$ W (b) $\frac{1}{3}$ W (c) W (d) 2 W

---

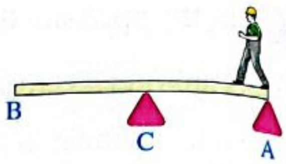
99 **In the opposite figure :**



$\overline{AB}$ is a non uniform rod of weight (w) rests in a horizontal position on two supports at C and D. If the reactions at the two supports are equal , then the point of action of the rod weight lies at the midpoint of ....

(a) $\overline{AB}$ (b) $\overline{CD}$ (c) $\overline{AD}$ (d) $\overline{BC}$

100 $\overline{AB}$ is a uniform rod rest horizontally on two supports , one of them at A and the other at the midpoint of the rod C.
A man moves on the rod from A towards B , then ....



(a) the rod will disturb its equilibrium when the man just passes the point A

(b) the rod will disturb its equilibrium when the man just passes the point C

(c) the rod will disturb its equilibrium before the man reach at point C

(d) the rod remains in equilibrium even the man reaches to B

---

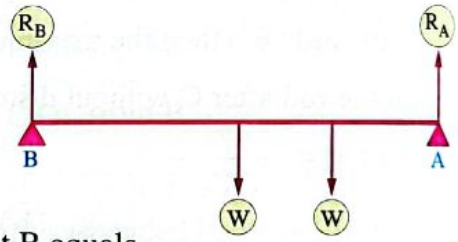
101 $\overline{AB}$ is a uniform rod of weight (W) rests horizontally on two supports one at (A) and the other at the midpoint of the rod (C) , then the reactions at (A) and (C) respectively are ....

(a) W , W (b) $\frac{1}{2}$ W , $\frac{1}{2}$ W (c) zero , W (d) W , zero

---

102 **In the opposite figure :**

$\overline{AB}$ is a uniform rod rests on two supports one at each end. A body of weight as weight as the rod is suspended at quarter the rod length from A , then the ratio between the reaction at A to the reaction at B equals ....



(a) $\frac{1}{2}$ (b) 2 (c) $\frac{3}{5}$ (d) $\frac{5}{3}$

---

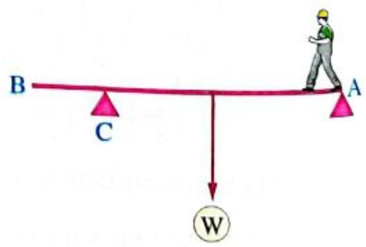
103 $\overline{AB}$ is a non uniform rod of weight 12 N. The rod will rest horizontally either on a smooth peg at point C where AC = 6 cm. , BC = 3 cm. or on two supports one at A and the other at B , then the reaction at A and B respectively are .... N.

(a) 6 , 6 (b) 3 , 9 (c) 8 , 4 (d) 4 , 8

---

104 **In the opposite figure :**

A uniform rod $\overline{AB}$ rests in a horizontal position on two supports one of them at A and the other at C on the rod. If a man moves from A towards B and the rod remains in equilibrium , then ....



(a) the reaction at A increases and the reaction at C decreases.

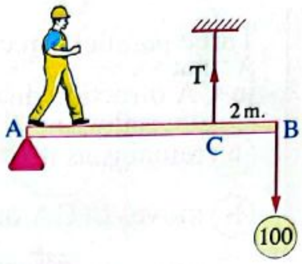
(b) the reaction at A decreases and the reaction at C increases.

(c) the reaction at A remains constant and the reaction at C remains constant.

(d) the reaction at A decreases till the man reaches to the rod centre then increases gradually.

105 **In the opposite figure :**

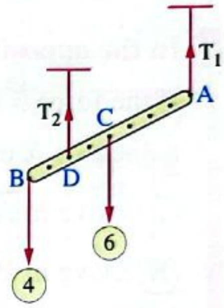
$\overline{AB}$ is a light board of length 6 m. , tied at one of its points (C) by a vertical rope. The rope cannot bear more than 400 N. A body of weight 100 N. is suspended from (B). A boy of weight 400 N. starts to move on the board from A toward the rope then the maximum distance the boy can move from A without breaking the rope = ... m.



(a) 1 (b) 1.5 (c) 2 (d) 2.5

106 **In the opposite figure :**

$\overline{AB}$ is a ruler. It was suspended from A and D by two vertical ropes. Two bodies of weight 6 N. and 4 N. are hanged from C and B. If the ruler is in equilibrium , then $T_1 : T_2$ = ...

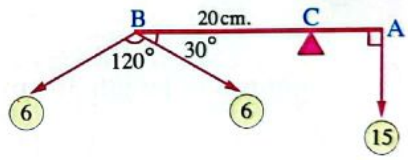


(a) 1 : 4 (b) 1 : 14

(c) 2 : 3 (d) 3 : 14

107 **In the opposite figure :**

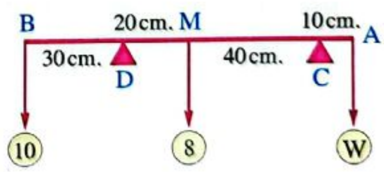
$\overline{AB}$ is a light rod. It rests at point C on a horizontal support. A body of weight 15 N. hangs at A. Two forces acts at B as shown in the figure. If the rod is in equilibrium horizontally , then AC = ... cm.



(a) 4 (b) 6 (c) 8 (d) 10

108 **In the opposite figure :**

$\overline{AB}$ is a uniform rod of weight 8 N. If a 10 N. weight is fixed at B , then the weight should be hanged at A to make the rod in equilibrium horizontally ∈ .... N.



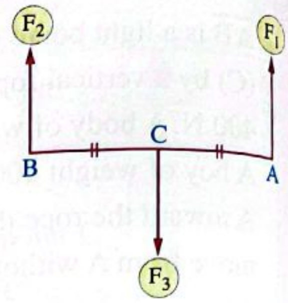
(a) [3 , 124] (b) {2 , 122} (c) [2 , 122] (d) [1 , 62]

109 $\overline{AB}$ is a non uniform rod , rests in a horizontal position on two supports at A and B. If the reaction at A equals twice the reaction at B. Where can a man of weight 3 times the rod stand on the rod and keeps the reaction at A twice the reaction at B ?

(a) At A (b) At B

(c) At the centre of the rod. (d) At the midpoint between A and the centre of the rod.

110 **In the opposite figure :**



Three parallel forces equal in magnitude If the force F_3 has moved in $\overrightarrow{CA}$ direction distance x , then the resultant ....

(a) remains as it is

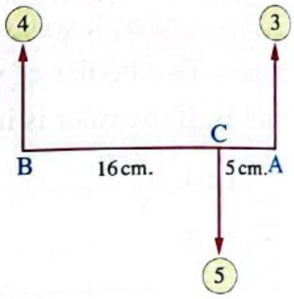
(b) moves in $\overrightarrow{CA}$ direction distance x

(c) moves in $\overrightarrow{CA}$ direction distance $\frac{1}{2}x$

(d) moves in $\overrightarrow{CB}$ direction distance x

---

111 **In the opposite figure :**



If the force 5 N has moved in $\overrightarrow{AB}$ direction a distance x cm. , then the resultant of the forces will ....

(a) move in $\overrightarrow{AB}$ direction distance $\frac{1}{2}x$

(b) move in $\overrightarrow{BA}$ direction distance $\frac{5}{2}x$

(c) moves in $\overrightarrow{BA}$ direction distance $\frac{5}{7}x$

(d) remain as it is with no movement.

---

112 A light rod of length 36 cm. is suspended in a horizontal position by means of two vertical strings. one of them at a point 9 cm. distance from one end. and the other from a point at 15 cm. distance from the other end. From the two ends two equal weight are suspended. Given that the maximum tension in each string is 54 gm.wt. , then the maximum value of each weight = ... gm. wt.

(a) 18 (b) 36 (c) 42 (d) 54

---

113 Three parallel forces F_1 , F_2 , F_3 act on a rod at the points A , B , C which are 2 cm. , 8 cm. , 6 cm. far from one end of the rod , if the rod is in equilibrium , then $F_1 : F_2 : F_3 =$ ....

(a) 1 : 2 : 3 (b) 2 : 3 : 1 (c) 3 : 2 : 1 (d) 1 : 3 : 2

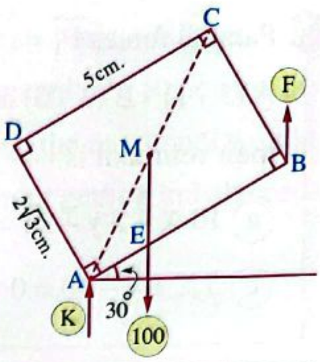
---

114 A uniform rod $\overline{AB}$ of length 60 cm. and weight 4 kg.wt. rests horizontally on two supports at A and C , where BC = 20 cm. When a vertical force of magnitude F acts at B , the rod is about to rotate about C , then the reaction at C = ... kg.wt.

(a) 2 (b) 4 (c) 6 (d) 8

115 **In the opposite figure :**

If the lamina ABCD is in equilibrium under action of the shown forces , then K – F = ...



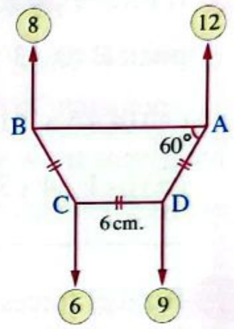
(a) 40 (b) 50

(c) 60 (d) 70

---

116 **In the opposite figure :**

ABCD is a trapezium , AD = DC = CB = 6 cm. , m (∠ DAB) = 60° , parallel forces of magnitude 12 , 8 , 6 , 9 N act at its vertices A , B , C , D respectively as shown , then the resultant of these forces acts at a distance .... cm. from A



(a) 2 (b) 3

(c) 4 (d) 5

---

117 ABCDEF is a regular hexagon , M is its centre and its side length is ℓ cm. , $\hat{e}$ is a unit vector in the plane of the hexagon and parallel to $\overrightarrow{CA}$

The forces $16\hat{e}$, $-6\hat{e}$, $-8\hat{e}$, $30\hat{e}$, $-18\hat{e}$ act at the points A , B , M , D and E respectively. Then the resultant of these forces = $14\hat{e}$ and acts at a point lying on $\overline{BE}$ at a distance .... cm. from M.

(a) $\frac{1}{2}\ell$ (b) $\frac{3}{14}\ell$ (c) $\frac{5}{14}\ell$ (d) $\frac{9}{14}\ell$

---

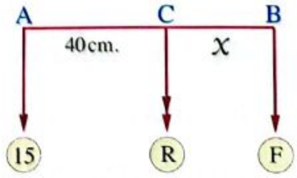
118 The parallel forces $\vec{F}_1$, $\vec{F}_2$, $\vec{F}_3$, $\vec{F}_4$ act at the points A (1 , 1) , B (– 2 , 1) , C (0 , 3) , D (– 2 , 0) respectively and these forces are in equilibrium.

If $\vec{F}_1 = \hat{i} + 2\hat{j}$, $\|\vec{F}_2\| = 2\sqrt{5}$ newton in opposite direction of $\vec{F}_1$, then $\vec{F}_4$ = ...

(a) $-2\hat{i} - 4\hat{j}$ (b) $-7\hat{i} - 14\hat{j}$ (c) $8\hat{i} + 16\hat{j}$ (d) $2\hat{i} + 4\hat{j}$

---

119 In the drawn figure : Two parallel forces of magnitudes 15 , F newtons acting at two points A , B respectively and their resultant acts at C ∈ $\overline{AB}$ such that AC = 40 cm. , CB = x cm. , if F (in newton) ∈ [10 , 20] , then x (in cm.) ∈ ....



(a) [30 , 60] (b) [60 , 90] (c) [20 , 40] (d) [40 , 80]

120 Parallel forces $\overrightarrow{F_1} = \hat{i} + m\hat{j}$, $\overrightarrow{F_2} = 3\hat{i} - 15\hat{j}$, $F_3 = n\hat{i} + 10\hat{j}$ act at the points A (3 , 1) , B (3 , 0) and C (3 , 5) respectively , then the equation of the line of action of their resultant is ....

(a) $10x + 2y - 21 = 0$
(b) $10x + 2y + 21 = 0$
(c) $5x + y - 10 = 0$
(d) $5x + y + 10 = 0$

---

121 If force $\overrightarrow{F_1} = 2\hat{i} - \hat{j} - 3\hat{k}$ acts at point A (1 , 2 , – 3) and force $\overrightarrow{F_2} = -4\hat{i} + 2\hat{j} + 6\hat{k}$ acts at point B (0 , 3 , 1) , then the line of action of their resultant intersects $\overleftrightarrow{AB}$ at ....

(a) (4 , 5 , – 1)
(b) (– 1 , 4 , 5)
(c) (– 1 , 4 , 3)
(d) (1 , 5 , – 2)

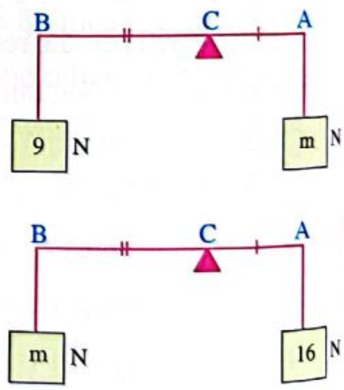
---

122 Parallel forces of magnitudes 5 , 8 , 12 N act in the same direction at the points A (2 , – 2) , B (0 , 3) , C (4 , – 1) respectively , then the point of action their resultant is ....

(a) (6 , 0)
(b) $\left(\frac{58}{25} , \frac{2}{25}\right)$
(c) $\left(\frac{2}{25} , \frac{57}{25}\right)$
(d) (2 , 0)

---

123 **In the opposite figure :**



If both systems are in equilibrium , then AC : CB = ...

(a) 9 : 16
(b) 3 : 4
(c) 16 : 9
(d) 4 : 3

---

124 $\overline{AB}$ is a non-uniform rod of length 65 cm. If a weight of magnitude 2 newton is fixed at the end B and a weight of 7 newton is suspended at the end A , the rod is in equilibrium horizontally at a point of distance 20 cm. from A. If the weight at A is decreased to become 4.2 newton , then the rod will be in equilibrium horizontally at a point of distance 25 cm. from A. , then the distance between the point of action of weight and the end A equals .... cm.

(a) 15
(b) 20
(c) 25
(d) 30

125 $\overline{AB}$ is a non-uniform rod of length 80 cm. and weight 20 newton rests horizontally on two supports at C and D such that AC = BD = 10 cm. A weight of magnitude 40 newton is suspended from A and the rod becomes about to rotate about C , then the maximum weight that can be suspended from B rising the suspended weight at A without getting imbalanced is .... N.

(a) 80 (b) 90 (c) 100 (d) 120

---

126 A non-uniform rod $\overline{ABCD}$ rests in equilibrium horizontally on two smooth supports at B and C such that AB = 6 cm. , CD = 7 cm. and the point of application of the bar weight divides the rod with a proportion 2 : 3 from the side A. It was found that if a weight of magnitude 120 gm.wt. is suspended from the end A , or if a weight of magnitude 180 g.wt. is suspended from the end D , then the bar in either cases is about to rotate , then the distance between the two supports = ... cm.

(a) 7 (b) 14 (c) 18 (d) 22

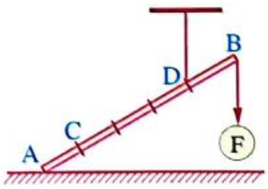
---

127 $\overline{AB}$ is a wooden beam of length 20 metres and weight 60 kg.wt. (acting at its midpoint) rests in a horizontal position on two supports at C and D , where AC = 3 m. and BD = 5 m. A man of weight 100 kg.wt. moves on the beam starting from the end A towards the end B , then the greatest distance , the man can move such that the beam does not overturn = ... m.

(a) 12 (b) 16 (c) 18 (d) 19

---

128 **In the opposite figure :**



$\overline{AB}$ is a uniform rod of weight (W) N.

and of length 5 length units.

C and D are two points where AC = DB = 1 unit length

, the rod is hanged by a light string from D , if a body of weight (F) N. is hanged from (B) the rod rests in equilibrium as shown in the figure with its end (A) on a smooth horizontal plane. If the part $\overline{AC}$ is removed from the rod , then the rod becomes in equilibrium in horizontal position

, then $\dfrac{\text{tension in the string in the first case}}{\text{tension in the string in the second case}}$ = ...

(a) $\frac{13}{8}$ (b) $\frac{8}{5}$ (c) $\frac{65}{64}$ (d) $\frac{64}{65}$

129 $\overline{AB}$ is a light rod hanged by two ropes at A and B and of length 120 cm. The ropes can not bear tension more than 5 kg.wt. At what point can 8 kg.wt. weight be hanged and make one of the two ropes about to break ?

(a) At a distance x from A where $x \in]0 , 45[$

(b) At a distance x from B where $x \in]0 , 45[$

(c) At a distance x from A where $x \in]45 , 75[$

(d) At a distance 45 cm. from one of the two ends.

---

130 A number (n) of coplanar equal in magnitude forces « each of them is of magnitude F » act in directions parallel to y-axis and direction of each is opposite to direction of its consecutive one if the first one is in the positive direction of y-axis and at distance 2 cm. from it and the distance between each force and its consecutive one = 2 cm. and the number of forces (n) is odd , then the algebraic sum of moments of these forces about the origin point equals ....

(a) $(n - 1) \times F$ (b) $(n + 1) \times F$ (c) $\frac{n-1}{2} \times F$ (d) $\frac{n+1}{2} \times F$

Fourth Questions on general equilibrium

Choose the correct answer from those given :

1. The necessary and sufficient conditions for the equilibrium of a set of coplanar forces ....

(a) is vanishing their resultant.

(b) that they must be intersecting at one point.

(c) that they must be parallel.

(d) is vanishing both of their resultant and the sum of their moments about any point.

---

2. If the resultant of set of coplanar forces is $\vec{R}$ and the sum of the moments of these forces is $\vec{M}$, then the condition for the equilibrium of the set is ....

(a) $\vec{R} = \vec{O}$, $\vec{M} = \vec{O}$ (b) $\vec{R} \neq \vec{O}$, $\vec{M} = \vec{O}$

(c) $\vec{R} = \vec{O}$, $\vec{M} \neq \vec{O}$ (d) $\vec{R} \neq \vec{O}$, $\vec{M} \neq \vec{O}$

---

3. If set of forces on the plane of rectangle ABCD and M_A = zero , X = zero , Y = zero then ....

(a) the set is equivalent to a couple. (b) the set is in equilibrium.

(c) the forces are parallel. (d) the forces intersect at one point.

---

4. If A , B and C are not collinear points and a set of forces lie on their plane where $\overrightarrow{M_A} = \overrightarrow{M_B} = \overrightarrow{M_C} = \vec{0}$, then...............

(a) the set of forces is in equilibrium. (b) the set of forces is equivalent to a couple.

(c) the forces are parallel. (d) the forces intersect at one point.

---

5. The set of coplanar forces in the same plane as the Δ ABC , if the forces are in equilibrium , then ....

(a) $M_A + M_B + M_C$ = zero (b) $M_A + M_B = 2\,M_C$

(c) $M_A = M_B = M_C$ = zero (d) All the previous.

6 The reaction of a hinge ....

(a) has no reaction at all.
(b) acts horizontally only.
(c) acts vertically only.
(d) has unknown direction.

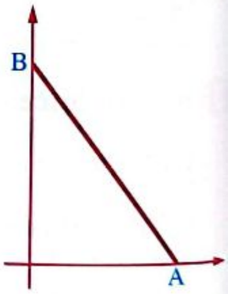
7 A rod rests at one of its points on a smooth support , then the reaction on this point is ....

(a) perpendicular to the rod and passing through the point of contact.
(b) parallel to the rod.
(c) acting in unknown direction.
(d) perpendicular to the rod and not passing through the point of contact.

8 When the end of a rod rests on a rough plane the reaction direction is ....

(a) perpendicular to the plane.
(b) parallel to the plane.
(c) changing according to the givens.
(d) making angle of measure 45° with the plane.

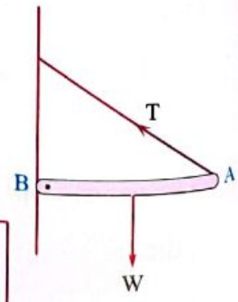
9 **In the opposite figure :**

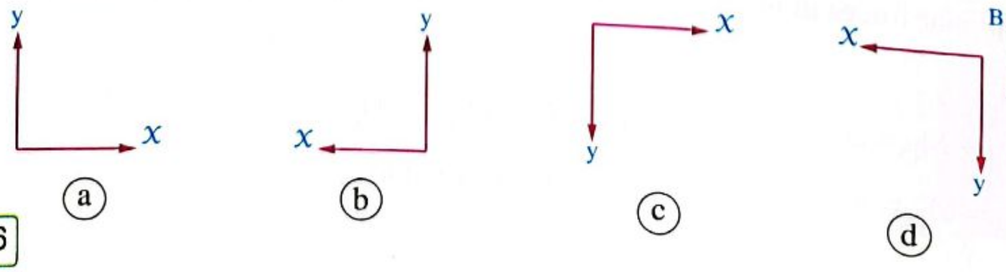


$\overline{AB}$ is a uniform rod , it rests with its upper end on a vertical wall and its lower end on a horizontal ground. In which of the following cases the rod could rest in equilibrium ?

(a) If the rod and the wall are smooth.
(b) If the ground is smooth and the wall is rough.
(c) If the ground is rough and the wall is smooth.
(d) In all the previous cases.

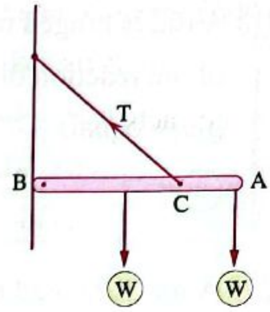
10 The opposite figure represents a regular rod in equilibrium then the directions of hinge reaction components at B are ....





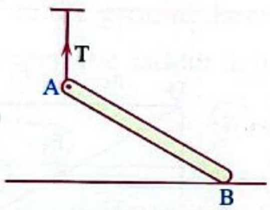
11 $\overline{AB}$ is a uniform rod , its end B is hinged to a vertical wall. The rod is suspended from a point C far from A quarter the rod length and the rod is in equilibrium in horizontal position.

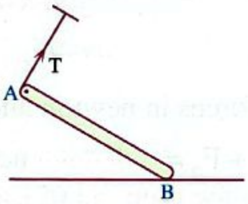
If a load of weight as many as the rod is suspended at A , then the direction of the reaction of the hinge is ....

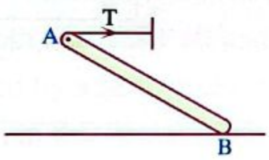


(a) ← (b) ↑ (c) → (d) ↗

12 A rod is suspended from one of its ends and the other end rests on a horizontal smooth floor. Which of the following represents equilibrium of the rod ?

(a) 

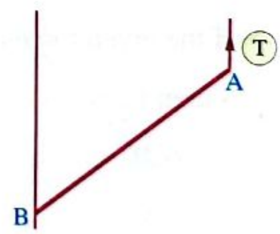
(b) 

(c) 

(d) The rod can not be in equilibrium.

13 **In the opposite figure :**

$\overline{AB}$ is a rod hanged from its end (A) by a vertical string and its end (B) is hinged in a vertical wall then the reaction of the hinge is ....



(a) perpendicular to wall. (b) vertically downward.
(c) vertically upward. (d) in $\overrightarrow{AB}$ direction.

14 A rod of weight W could rest on a smooth horizontal floor and a rough vertical wall and the coefficient of static friction between the rod and the wall equals μ_s ....

(a) If $\mu_s < W$ (b) If $\mu_s > 1$
(c) If $\mu_s = 1$ (d) the rod can not be in equilibrium.

15 A body is under action of forces : $\overrightarrow{F_1} = 2\hat{i} - a\hat{j}$, $\overrightarrow{F_2} = 5\hat{i} + 2\hat{j}$, $\overrightarrow{F_3} = b\hat{i} - 5\hat{j}$, then if the body is in equilibrium , then (a , b) = ...

(a) (3 , 7) (b) (– 3 , 7) (c) (3 , – 7) (d) (– 3 , – 7)

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16 A rod is hinged to a vertical wall , X_1 and Y_1 are the algebraic perpendicular components of the reaction of the hinge and if $X_1 = 3$ kg.wt. , $Y_1 = 4$ kg.wt. , then the reaction of the hinge equals .... kg.wt.

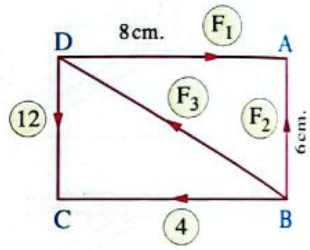
(a) 1 (b) 5 (c) 7 (d) 12

17 A rod is hinged to a vertical wall , X_1 and Y_1 are the algebraic perpendicular components of the reaction of the hinge $\vec{R}$ and if $X_1 = a$ kg.wt. , $Y_1 = a\sqrt{3}$ kg.wt. and $R = 10$ kg.wt. , then a = ...

(a) 3 (b) 4 (c) 5 (d) 10

18 **In the opposite figure :**

If the magnitude of the forces in newton and the system is in equilibrium , then $F_1 + F_2 =$ .... newton.

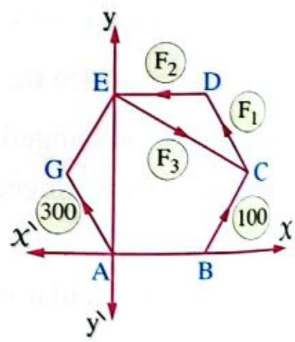


(a) 19 (b) 16
(c) 8 (d) 11

19 **In the opposite figure :**

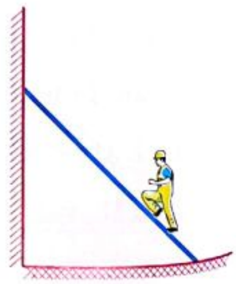
ABCDEG is a uniform hexagon with side length 40 cm.

If the given forces are in equilibrium , then $F_2 =$ .... newton.



(a) 600 (b) $300\sqrt{3}$
(c) 100 (d) 150

20 A man climbs a ladder. The ladder rests with its upper end on a smooth vertical wall and its lower end on a horizontal rough floor. As long as the man ascends (and the ladder does not slide) as ....

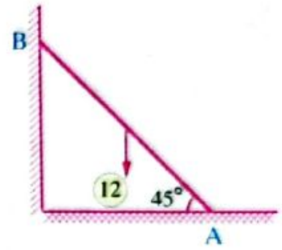


(a) the reaction of the wall increases.
(b) the friction between the ladder and the floor increases.
(c) the total pressure of the ladder on the floor increases.
(d) all the previous.

21 A uniform ladder rests with its upper end against a smooth vertical wall and its lower end on a rough horizontal ground. If the ladder is about to move when it makes an angle of measure 45° to the horizontal then the coefficient of static friction equals ....

(a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{3}}$ (c) 1 (d) $\frac{\sqrt{3}}{2}$

22 **In the opposite figure :**



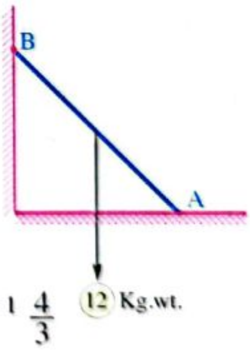
$\overline{AB}$ is a uniform ladder of weight 12 kg.wt. rests with its lower end A on a rough horizontal ground and its upper end B against a smooth vertical wall the ladder makes an angle 45° to the ground then the magnitude of the frictional force between the ladder and the ground = ... kg.wt.

(a) 12 (b) 3 (c) 1 (d) 6

23 $\overline{AB}$ is a uniform rod of length 17 m and mass 120 kg. rests with its upper end B against a smooth vertical wall and its lower end A on a smooth horizontal plane. Its lower end A is attached by a horizontal string to point C vertically below B where AC = 8 cm. , then the tension in the string = ... kg.wt.

(a) 32 (b) 16 (c) 64 (d) 8

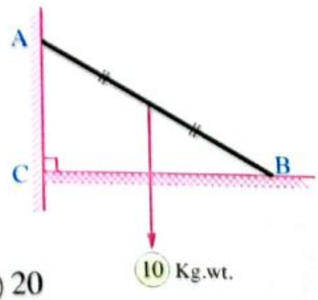
24 **In the opposite figure :**



$\overline{AB}$ is a uniform rod of weight 12 kg.wt. Its end A rests on a rough horizontal ground and its end B on a smooth vertical wall. If the reaction of the wall = $4\sqrt{3}$ kg.wt. and the rod is about to slide , then the measure of the angle of friction between the ground and the rod is ....

(a) 30° (b) 45° (c) 60° (d) $\tan^{-1}\frac{4}{3}$

25 ***(Trial 2021)* In the opposite figure :**



A uniform rod of weight 10 kg.wt. rests with its end A on a smooth vertical wall and with its end B on a rough horizontal ground the coefficient of static friction between the rod and the ground is $\frac{1}{2}$ and the rod about to slide , then the reaction of the wall on the rod = ...kg.wt.

(a) 2.5 (b) 5 (c) 10 (d) 20

26 The upper end of a ladder rests on a smooth wall and its lower end on a horizontal rough plane , the coefficient of static friction between them = $\frac{1}{4}$ and it was about to slide , then the angle of inclination between the ladder and the vertical equals ....

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$ (c) $\tan^{-1}\frac{1}{4}$ (d) $\tan^{-1}\frac{1}{2}$

27 A uniform rod rests in a vertical plane on a smooth vertical wall with its upper end and on a rough horizontal plane with its lower end the coefficient of static friction between the horizontal plane and the rod equals $\frac{3}{4}$, then the tangent of the angle the rod makes to the horizontal when the rod is about to slip equals ....

(a) 0.5 (b) 1 (c) 1.2 (d) $\frac{2}{3}$

28 A regular ladder rests with its lower end on a horizontal rough plane and its upper end on a smooth vertical wall , the angle between the ladder and vertical plane is (θ) , the ladder is in limiting equilibrium and the coefficient of static friction (μ_s) , then : tan θ equals ....

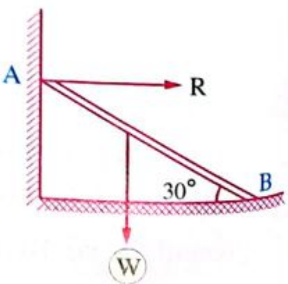
(a) μ_s (b) $2\mu_s$ (c) $\frac{3\mu_s}{2}$ (d) $\mu_s + 1$

29 $\overline{AB}$ is a uniform rod of weight (w) rests with its upper end A on a smooth vertical wall and its lower end B on a rough horizontal plane. The rod is about to move , then the reaction of the wall on the end A equals ....

(a) $\mu_s w$ (b) w (c) $\frac{w}{\mu_s}$ (d) the normal reaction at B

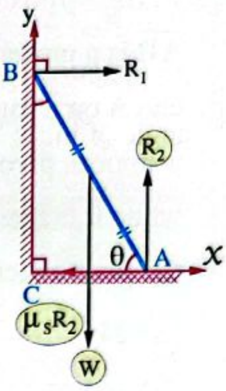
30 **In the opposite figure :**

$\overline{AB}$ is a uniform ladder of weight (W) rest with its upper end A against a smooth the vertical wall and its lower end B on a rough horizontal ground and the measure of inclination of the ladder to the ground is 30°. If the ladder is in equilibrium and the reaction at A equals $8\sqrt{3}$, then the reaction at B equals ....



(a) $16\sqrt{3}$ N (b) $8\sqrt{3}$ N (c) 8 N (d) 16 N

31 **In the opposite figure :**



If the rod in limiting equilibrium

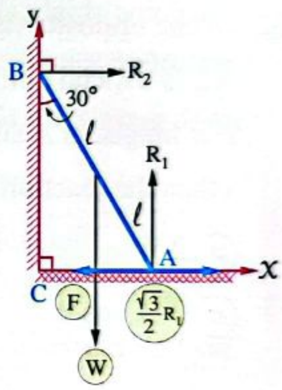
, then $R_2 - R_1 =$ ....

(a) $W(\mu_s - 1)$ (b) $(1 - \mu_s)$

(c) $W(1 - \mu_s)$ (d) $(\mu_s - 1)$

---

32 **In the opposite figure :**



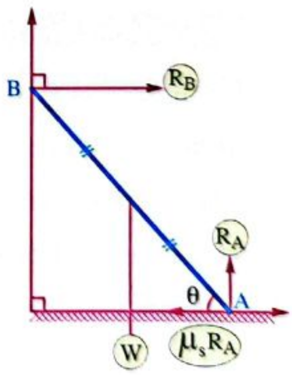
If the rod is about to move towards the wall under action of the force its magnitude F , then F = ...

(a) $\frac{2\sqrt{3}}{3}$ W (b) $\frac{\sqrt{3}}{3}$ W

(c) $2\sqrt{3}$ W (d) $\frac{3\sqrt{3}}{2}$ W

---

33 **In the opposite figure :**



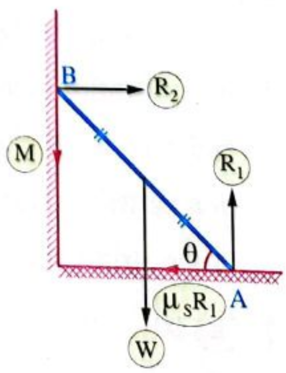
Let λ be the friction angle between the ground and the rod , then : tan θ. tan λ ....

(a) 3 (b) 1

(c) 2 (d) $\frac{1}{2}$

---

34 **In the opposite figure :**

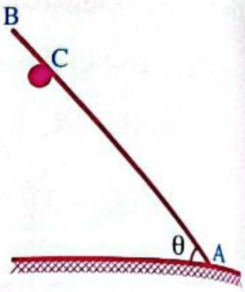


The ladder $\overline{AB}$ is about to slide where $\tan\theta \tan\lambda = \frac{3}{4}$ where λ is the angle of friction , then W .... M

(a) > (b) <

(c) = (d) ≥

35 **In the opposite figure :**

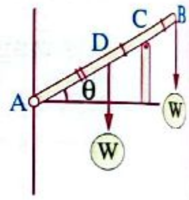


$\overline{AB}$ is a uniform of length 24 cm. and weight 50 gm.wt. rests with end A on a rough horizontal plane and one of its points (C) on a smooth pivot where BC = 4 cm. The rod is kept in equilibrium when it makes angle θ with the horizontal where $\tan \theta = \frac{3}{4}$, then the pivot reaction = ·············· gm.wt.

(a) 24 (b) 18
(c) 30 (d) 20

---

36 **In the opposite figure :**

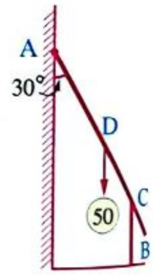


$\overline{AB}$ is a metal uniform rod of weight (W) kg.wt.
It is hinged at A and rests on a smooth vertical support at C , then the reaction at C = ·············· kg.wt.

(a) 2 W (b) 2 W sin θ
(c) 2 W cos θ (d) 2 W tan θ

---

37 ***(Trial 2021)*** **In the opposite figure :**



$\overline{AB}$ is a uniform rod of length 30 cm. and weight 50 gm.wt.
It is hinged at A to a vertical wall and one of its points C at a distance 5 cm. from B , rests on a smooth vertical barrier , the rod rests when it makes an angle of measure 30° to the vertical , then the reaction of the barrier equals ·············· gm.wt.

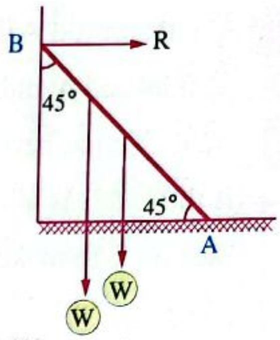
(a) $25\sqrt{3}$ (b) 25 (c) $15\sqrt{3}$ (d) 15

---

38 A uniform ladder $\overline{AB}$ of weight 10 kg.wt. and of length 3 metres rests with its lower end A on a smooth horizontal ground and its upper end B against a smooth vertical wall. It is kept in equilibrium when inclined at an angle of measure 45° to the ground by joining the lower end A by a string to the junction of the wall and the ground lies vertically directly below B in a vertical plane. If a man of weight 60 kg.wt. has ascended the ladder , then the tension of the string when the man has ascended to a point 2 metres apart from A equals ·············

(a) 10 (b) 20 (c) 35 (d) 45

39 **In the opposite figure :**



A uniform ladder of length (ℓ) and weight (W) rests with its lower end A on a rough horizontal ground and its end B against a smooth vertical wall if the greatest distance a man of weight equals to the ladder weight can ascends is $\frac{3}{4}\ \ell$, then the reaction of the wall at B = ...

(a) $\frac{1}{2}$ W (b) $\frac{1}{4}$ W (c) $\frac{3}{4}$ W (d) $\frac{5}{4}$ W

---

40 A uniform ladder of weight 20 kg.wt and length ℓ cm. rests in a rough horizontal ground with one of its ends and the other end on a smooth vertical wall. The ladder is being kept in a vertical plane and inclined at 60° to the horizontal. If it is known that the coefficient of static friction between the ladder and the ground equals $\frac{1}{2\sqrt{3}}$, then the maximum distance a girl of weight 60 kg.wt. can ascend up the ladder is equal to .... cm.

(a) $\frac{1}{5}\ \ell$ (b) $\frac{1}{4}\ \ell$ (c) $\frac{1}{3}\ \ell$ (d) $\frac{1}{2}\ \ell$

---

41 $\overline{AB}$ is a uniform ladder of weight 100 kg.wt. rests at its end B against a smooth vertical wall and it rests at its end A on a rough horizontal ground when the ladder is inclined to the ground at an angle of measure 60°. If a man of weight 150 kg.wt. could ascend to the top of the ladder at then the ladder is about to slide , then the coefficient of static friction between the end A of the ladder and the ground = ...

(a) $\sqrt{3}$ (b) $\frac{\sqrt{3}}{15}$

(c) $\frac{4\sqrt{3}}{15}$ (d) $\frac{8\sqrt{3}}{15}$

---

42 $\overline{AB}$ is a uniform beam of weight 20 newton rests at its end A on a rough horizontal ground and rests at its end B against a smooth vertical wall such that the beam is in a vertical plane perpendicular to the wall and it is inclined at the horizontal ground with an angle of measure 45° , then the value of a horizontal force acting on A to make the beam about to slide away from the wall giving that the coefficient of static friction between the beam and the ground is $\frac{3}{4}$ = ... N.

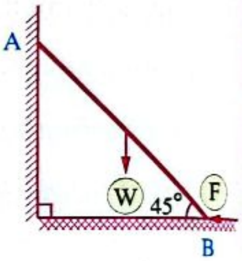
(a) 5 (b) 10 (c) 15 (d) 20

43 A uniform rod $\overline{AB}$ of length 260 cm. and weight 43 newtons rests on a rough vertical wall with its end A and on a rough horizontal ground with its end B. If the two coefficients of static friction between the rod and both the wall and ground are $\frac{1}{4}$ and $\frac{1}{2}$ respectively. If the end B is at a distance 100 cm. from the wall , then the horizontal force acting at the end B to make the rod be about to move towards the wall = ... newton.

(a) 28.25 (b) 30.75 (c) 32.75 (d) 36.25

44 **In the opposite figure :**

$\overline{AB}$ is a uniform rod of weight (W) rests with its ends A against a smooth vertical wall and its end B on a rough horizontal ground , the coefficient of static friction between them is $\frac{3}{4}$ If a horizontal force acted on the rod at the point B to make it about to move towards the wall when the rod inclined to the horizontal by an angle of measure 45° , then the magnitude of the horizontal force = ...

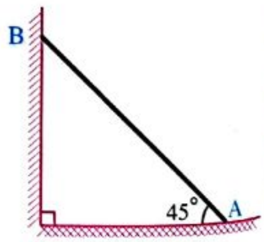


(a) $\frac{1}{4}$ W (b) $\frac{5}{4}$ W

(c) $\frac{3}{4}$ W (d) $\frac{7}{4}$ W

45 ***(1st Session 2021)*** **In the opposite figure :**

$\overline{AB}$ is a non-uniform ladder of length 4 metre and weight 200 newton. rests with its end A on a rough horizontal ground the coefficient of static friction between them is $\frac{3}{5}$ and its end B rests against a smooth vertical wall. If the ladder is about to slide when it inclined to the horizontal by an angle of measure 45° , then the point of action of its weight is at a distance .... cm. from A.

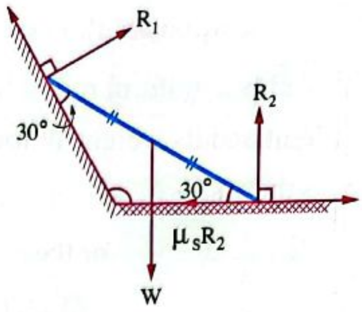


(a) 120 (b) 200 (c) 240 (d) 100

46 A uniform ladder rests in a vertical plane with one end on the floor and the other end against a vertical wall , the floor and wall are rough and the angle of static friction of each is λ , then when the ladder is on the brink of sliding , its inclination to the wall is ....

(a) λ (b) $\frac{1}{2}\lambda$ (c) 2λ (d) 4λ

47 In the opposite figure :



If rod $\overline{AB}$ is in equilibrium

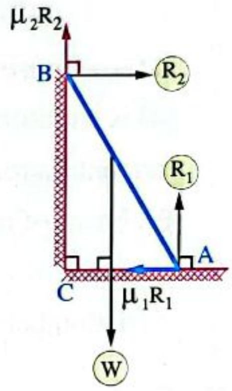
, then $\mu_s =$ ....

(a) $\frac{2}{\sqrt{3}}$ (b) $\frac{\sqrt{3}}{3}$

(c) $\frac{1}{3}$ (d) $\sqrt{3}$

---

48 In the opposite figure :



Both horizontal and vertical planes are rough. The coefficient of friction between the two planes and a rod are μ_1 , μ_2 respectively.

The rod could be about to move if ....

(a) $R_2 = \mu_1 W$ (b) $\mu_1 R_1 = \mu_2 R_2$

(c) $\mu_1 = \frac{R_2}{R_1}$ (d) $\mu_2 = \frac{R_1}{R_2}$

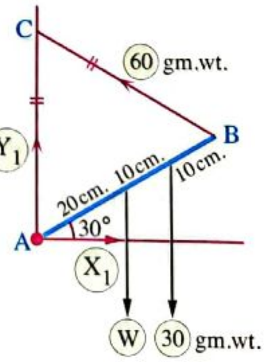
---

49 A uniform ladder $\overline{AB}$ of weight 9 kg.wt. rests on rough horizontal ground with its end A and on a rough vertical wall with its end B. If the two coefficient of static friction at A and B are $\frac{5}{6}$ and $\frac{1}{2}$ respectively , then the end A is pulled by a horizontal force $\vec{F}$ making the ladder be about to slip away from the wall and the ladder makes an angle of measure 45° to the horizontal , then the magnitude of force F = ... newton. (the ladder is in a vertical plane perpendicular to the wall)

(a) 3.25 (b) 6.5 (c) 9.75 (d) 13

---

50 In the opposite figure :



If the rod $\overline{AB}$ is in equilibrium and AB = 40 cm. ,

the tension in $\overline{BC}$ equals 60 gm.wt. ,

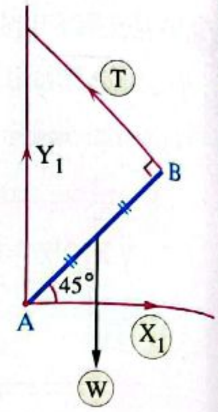
then W = ... gm.wt.

(a) 60 (b) 75

(c) 90 (d) 100

51 **In the opposite figure :**

$\overline{AB}$ is a uniform rod of length ℓ unit and its weight W force unit , then $Y_1 - X_1 =$ .... force unit.

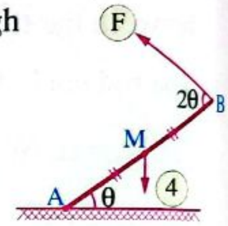


(a) $\frac{1}{2}$ W (b) $\frac{1}{3}$ W

(c) $\frac{2}{3}$ W (d) zero

52 **In the opposite figure :**

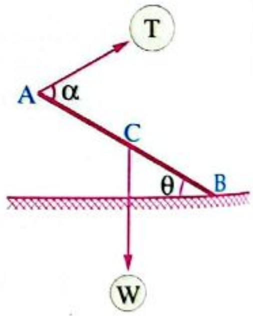
$\overline{AB}$ is a uniform rod of weight 4 kg.wt. It rests with its end (A) on a rough horizontal ground and makes with the horizontal an angle of measure (θ). Force of magnitude 2 kg.wt. acts on the rod and makes an angle of measure 2θ with the rod if the rod is about to slide , then the coefficient of friction between the rod and the ground = ...



(a) $\frac{1}{2}$ (b) $\frac{2}{3}$ (c) $\frac{\sqrt{3}}{2}$ (d) $\frac{\sqrt{3}}{3}$

53 **In the opposite figure :**

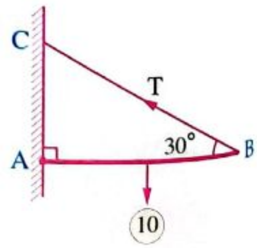
$\overline{AB}$ is a uniform rod in equilibrium position. It rests with its end B on a rough horizontal ground and tied with a light string from A. If $\alpha + \theta = 90°$, then T = ...



(a) W (b) $\frac{1}{2}$ W (c) 2 W (d) W tan θ

54 ***(Trial 2021)*** **In the opposite figure :**

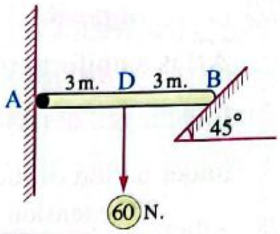
$\overline{AB}$ is a uniform rod of weight 10 kg.wt. the rod is hinged at A to a vertical wall and tied at B with a light inextensible string and inclined to the rod at an angle of measure 30° and the other end of the string fixed at C vertically above A , then the tension in the string which keeps the rod in horizontal position = ... kg.wt.



(a) 5 (b) 10 (c) 20 (d) $\frac{10}{3}$

55 ***(1st Session 2021)*** **In the opposite figure :**

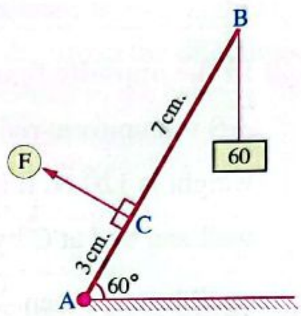
$\overline{AB}$ is a uniform rod of length 6 m. and of weight 60 newton its end A is attached to a fixed hinge at a vertical wall and its end B rests against a smooth plane inclined to the horizontal by an angle of measure 45° , if the rod equilibrated horizontally , then the magnitude of the reaction at the hinge (A) = ... newton.



(a) $15\sqrt{2}$ (b) $30\sqrt{2}$ (c) 30 (d) 15

56 ***(Trial 2021)*** **In the opposite figure :**

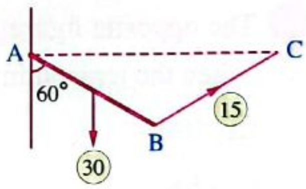
$\overline{AB}$ is a light rod connected at A with a hinge fixed to a horizontal ground. Force F acts on the rod perpendicular to the rod at point C where CA = 3 cm. , CB = 7 cm. A body of weight 60 gm.wt. hanged at B and the rod kept in equilibrium when it is inclined to the horizontal at an angle of measure 60° , then the reaction of the hinge at A = ... gm.wt.



(a) $15\sqrt{19}$ (b) $10\sqrt{19}$ (c) $20\sqrt{19}$ (d) $25\sqrt{19}$

57 ***(Trial 2021)*** **In the opposite figure :**

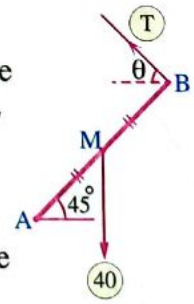
$\overline{AB}$ is a uniform rod of weight 30 N. Its end A is hinged to a vertical wall and its end B is tied to a light inextensible string. The other end of the string is tied to point C lies on the same horizontal plane as A , the rod is in equilibrium when the tension in the string is 15 N. If AB = BC and the points A , B and C lies in the same vertical plane perpendicular to the wall and the rod inclined to the wall at an angle of measure 60° , then the reaction of the hinge inclined to $\overline{AC}$ at an angle of measure ....°



(a) zero (b) 90 (c) 120 (d) 180

58 ***(2nd Session 2021)*** **In the opposite figure :**

$\overline{AB}$ is a uniform rod of weight 40 kg.wt. its end A is attached to a fixed hinge and its end B is pulled by a light inelastic string inclined to the horizontal by an acute angle of measure θ , the rod equilibrated when it makes an angle of measure 45° with the horizontal. If the magnitude of the reaction of the hinge in equilibrium position = $10\sqrt{10}$ kg.wt. , then the reaction of the hinge inclined to the horizontal by angle of tangent = ...



(a) $\frac{1}{3}$ (b) 3 (c) $\frac{1}{2}$ (d) 1

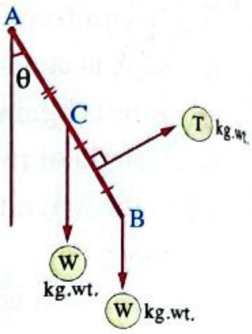
59 **In the opposite figure :**

$\overline{AB}$ is a uniform rod of weight (W) kg.wt.

It is hinged at (A) , if the rod is in equilibrium

under action of the given forces shown in the figure

, then $\frac{\text{The tension in the string}}{\text{The reaction of the hinge}}$ = ...

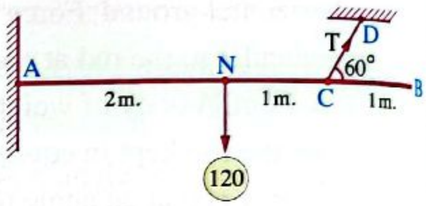


(a) 2 W sin θ (b) 2 W cos θ

(c) W tan θ (d) tan θ

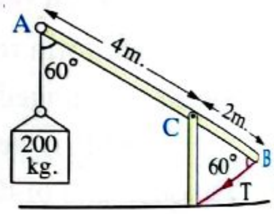
60 **In the opposite figure :**

$\overline{AB}$ is a uniform rod of length 4 m. and its weight is 120 N. It is hinged at A to a vertical wall and tied at C by a string $\overline{CD}$ If the rod is in equilibrium , then $\frac{\text{The reaction of the hinge at A}}{\text{The tension in the string } \overline{CD}}$ = ...



(a) $\sqrt{7} : 4$ (b) $\sqrt{7} : 3$ (c) $\sqrt{7} : \sqrt{3}$ (d) $\sqrt{7} : 2\sqrt{3}$

61 The opposite figure shows a crane in equilibrium position , then the tension in the string (T) = ... kg.wt.



(a) 100 (b) 200

(c) 300 (d) 400

62 $\overline{ABC}$ is a uniform rod of length 40 cm. and of weight 30 kg.wt. can rotate about a hinge at its end A , a thin wire is attached at B and its other end is fixed at a point 40 cm. apart from A and lies vertically directly above A such that the rod is in horizontal position.

If BC = 10 cm. , then the magnitude of the tension in the wire = ... kg.wt.

(a) 45 (b) 35 (c) 30 (d) 25

63 A uniform rod hinged at A to a vertical wall, weighs 10 newton and is 200 cm. long , A weight equals to that of the rod is hung from the end B and the rod is kept horizontal by a rope tied to a point on it 150 cm. from A and the other end is fixed to the wall at a point above A. If the rope is inclined at 30° to the horizontal position. Then the reaction at the hinge = ... newton.

(a) $10\sqrt{3}$ (b) $20\sqrt{3}$ (c) $30\sqrt{3}$ (d) $40\sqrt{3}$

64 $\overline{AB}$ is a uniform rod of length 160 cm. and of weight 300 gm. wt. is hung at a fixed nail C by means of two strings tied at the ends A and B , a weight of magnitude 600 gm.wt. is suspended at the point N on the rod. If the rod is in equilibrium horizontally when the two strings $\overline{AC}$ and $\overline{BC}$ are inclined to the rod at two angles of measures 60° and 30° respectively , then the length of $\overline{AN}$ = ... cm.

(a) 10 (b) 20 (c) 30 (d) 40

---

65 $\overline{AB}$ is a uniform rod of weight 16 kg.wt. and of length 4.2 metres , C and D are two points on the rod where AC = 1.2 metre , BD = 0.6 metre , the rod is susbended from C and D by two strings $\overline{EC}$ and $\overline{OD}$. A force of magnitude $7\frac{1}{2}$ kg.wt. acted on the rod in the direction $\overrightarrow{AB}$ to make the string $\overline{OD}$ in vertical position and the string $\overline{EC}$ inclined to the horizon , then the rod becomes in equilibrium in horizontal position , then $\overline{EC}$ is inclined to the horizon with an angle of tangent ....

(a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{3}{4}$ (d) $\frac{4}{3}$

---

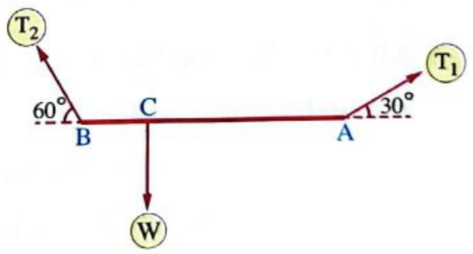
66 $\overline{AB}$ is a light fine rod of length 2ℓ connected in a vertical plane at its two ends A , B by two strings inclined at 30° , 60° to the vertical respectively , two weights of 2 , 8 newtons are suspended on the rod distant $\frac{1}{5}\ell$, $\frac{6}{5}\ell$ from A then in the case of equilibrium , the measure of the angle of inclination of the rod to the horizontal = ...

(a) 15° (b) 30° (c) 45° (d) 60°

---

67 **In the opposite figure :**

A non-uniform rod $\overline{AB}$ is hanged from its ends by two ropes. The rope at A makes an angle of measure 30° with the horizontal and the rope at B makes an angle of measure 60° with the horizontal. If the rod rests in horizontal position , then the point of action of its weight (C) divides the rod by ....



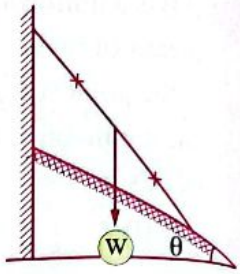
(a) 1 : 1 (b) 1 : 3 from A (c) 1 : 3 from B (d) 1 : 4 from B

---

68 A light rod of length L rests in horizontal position on a support as shown in the figure , the mass m is balanced with the two masses m_1 or m_2 separately as in the figure , then the value of m in terms of m_1 , m_2 equals ....

(a) $m_1 + m_2$ (b) $\frac{1}{2}(m_1 + m_2)$ (c) $m_1\, m_2$ (d) $\sqrt{m_1\, m_2}$

69 **In the opposite figure :**

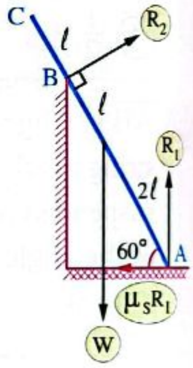


A uniform ladder of weight (w) rests at one of its ends against a smooth vertical plane and the other end rests on a rough inclined ground makes with the horizon the angle θ. If the ladder is about to slide , where it lies in the vertical plane perpendicular to the line of junction on the wall and the ground , then the ladder inclines to the vertical with an angle of tangent ………… where λ is the angle of static friction between the ladder and the ground.

(a) $\tan(\lambda - \theta)$ (b) $\tan(\lambda + \theta)$ (c) $2\tan(\lambda - \theta)$ (d) $2\tan(\lambda + \theta)$

---

70 **In the opposite figure :**



$\overline{AC}$ is a uniform rod about to move , placed with the point B on a smooth vertical wall and with its end A on a rough horizontal ground , then $\mu_s =$ …………

(a) $\frac{5}{\sqrt{3}}$ (b) $\frac{\sqrt{3}}{5}$

(c) $\frac{\sqrt{5}}{3}$ (d) $\frac{3}{\sqrt{5}}$

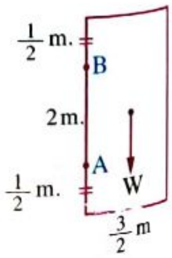
---

71 $\overline{AB}$ is a uniform ladder of length 5 metres and of weight 20 kg.wt. rests at the end A against a smooth vertical wall and rests at B on a rough horizontal ground, the coefficient of static friction between them is $\frac{1}{4}$ and the end B is 3 metres apart from the wall , then the smallest weight of a body can be placed at the end B of the ladder to prevent sliding if the coefficient of static friction between the body and the ground is $\frac{1}{5}$ equals ………… kg.wt.

(a) 12.5 (b) 17.5 (c) 20 (d) 25

---

72 **In the opposite figure :**

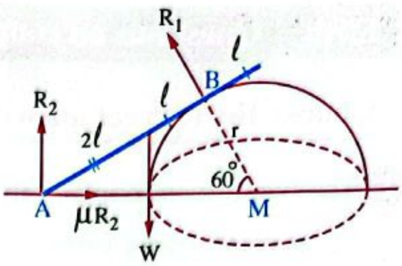


If the door is in equilibrium and its weight is equally distributed between the two hinges at A and B , then $R_1 = R_2 =$ …………

(a) $\frac{5}{8}$ (b) $\frac{8}{5}$ (c) $\frac{5}{8}$ w (d) $\frac{8}{5}$ w

73 In the opposite figure :

A smooth hollow hemi-sphere vessel rests with its circular base on a rough horizontal ground and a uniform rod of length (4ℓ) and of weight (w) rests at it such that one of its points touches the external surface of the vessel at (B) and its free end (A) rests on the ground if the rod is about to slide when $AB = 3\ell$, m ($\angle BMA$) = 60°



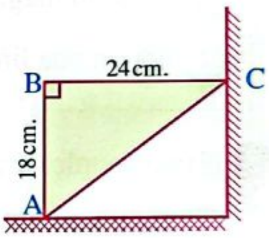
Then : $R_2 \div R_1 = \dots\dots\dots$

(a) $\frac{\sqrt{3}}{2}$ (b) $\frac{\sqrt{2}}{2}$ (c) $\sqrt{3}$ (d) $\frac{2\sqrt{3}}{3}$

---

74 In the opposite figure :

ABC is a uniform lamina in form of a right-angled triangle and has weight of 120 N. It rests with its vertex A on a rough horizontal ground and its vertex (C) rests on a smooth vertical wall if the lamina is in equilibrium and its vertex A is about to slide when $\overline{AB}$ is vertical , then the coefficient of friction between (A) and the ground = $\dots\dots\dots$



(a) $\frac{2}{9}$ (b) $\frac{4}{9}$ (c) $\frac{5}{9}$ (d) $\frac{7}{9}$

Fifth Questions on couples

Choose the correct answer from the given ones :

1. The two forces acting on the steering wheel of a car and producing the rotation of the steering wheel form ....

(a) friction.

(b) couple.

(c) perpendicular force on the steering wheel.

(d) non-zero resultant.

2. To form a couple of two forces , the two forces should be ....

(a) equal in magnitudes.

(b) opposite in directions.

(c) not on one line of action.

(d) all what previously mentioned.

3. If two couples are equivalent , then ....

(a) the magnitude of all forces of the two couples are equal.

(b) the arm of the first couple = the arm of the second.

(c) the sum of algebraic measures of the couple moment = Zero.

(d) the algebraic measure of the moment of the two couples are equal.

4. Which of the following conditions does not change the effect of the couple on the body ?

(a) Translating the couple into a new position in its plane.

(b) Translating the couple into another plane parallel to its plane.

(c) Rotating the couple in its same plane.

(d) All what previously mentioned.

5. If a body is under action of two coplanar couples, their moments $\overrightarrow{M_1}$, $\overrightarrow{M_2}$ and $\overrightarrow{M_1} \neq \overrightarrow{M_2}$, $M_1 + M_2 \neq$ Zero , then ....

(a) the body is in equilibrium.

(b) the two couples are equivelant.

(c) the body moves in a straight line.

(d) the body moves in cyclic motion.

6. If the norm of the moment of a couple is 350 newtons. m and the magnitude of one of its two forces is 70 newtons , then the arm length of the moment of the couple is equal to ....

(a) 50 m. (b) 5 m. (c) 5 cm. (d) 24500 cm.

---

7. A couple formed from two forces the magnitude of each is 12 N and the perpendicular distance between them is 8 cm. , is equivalent to a couple formed from two forces the perpendicular distance between them is 6 cm. and the magnitude of each = ...

(a) 8 N. (b) 16 N. (c) 12 N. (d) 4 N.

---

8. $\vec{F}_1$ and $\vec{F}_2$ are two forces form a couple and $\vec{F}_1 = 3\hat{i} - 2\hat{j}$, then $\vec{F}_2 =$ ....

(a) $3\hat{i} - 2\hat{j}$ (b) $-3\hat{i} + 2\hat{j}$ (c) $2\hat{i} - 3\hat{j}$ (d) $-3\hat{i} - 2\hat{j}$

---

9. If $4\vec{F}_1$, $3\vec{F}_2$ are two forces of a couple and $\vec{F}_1 = 6\hat{i} - 9\hat{j}$, then : $\vec{F}_2 =$ ....

(a) $-8\hat{i} + 12\hat{j}$ (b) $8\hat{i} - 12\hat{j}$ (c) $12\hat{i} - 8\hat{j}$ (d) $-12\hat{i} + 8\hat{j}$

---

10. Two forces $\vec{F}_1 = 4\hat{i} - a\hat{j}$, $\vec{F}_2 = 2b\hat{i} + 5\hat{j}$ form a couple , then $2a + b =$ ....

(a) -12 (b) -9 (c) 8 (d) 12

---

11. If the two forces $\vec{F}_1 = 5\hat{i} + a\hat{j} + 3\hat{k}$, $\vec{F}_2 = b\hat{i} - 9\hat{j} + c\hat{k}$ form a couple , then $a + b + c =$ ....

(a) -1 (b) Zero (c) 1 (d) 17

---

12. *(Trial 2021)* If $\vec{F}_1 = (a , -3)$, $\vec{F}_2 = (1 , 1)$, $\vec{F}_3 = (1 , b - a)$ is equivalent to a couble , then $a + b =$ ....

(a) -1 (b) -2 (c) 1 (d) 3

---

13. *(1st Session 2021)* If the force $\vec{F}_1 = (3 , -1)$ acts at the point A (1 , 2) , $\vec{F}_2$ acts at the point B (– 1 , 1) and the two forces form a couple , then the algebraic measure of the moment of the couple = ... moment unit.

(a) 5 (b) 2 (c) -5 (d) -2

14 If $\overrightarrow{F_1}, \overrightarrow{F_2}$ are the two forces of a couple such that $\overrightarrow{F_1} = -3\,\hat{i} + 2\,\hat{j}$ acts at the point A (1 , 1) , $\overrightarrow{F_2}$ acts at the point B (–1 , –2) then the moment of the couple and the length of the arm drawn from A to the line of action of $\overrightarrow{F_2}$ are ....

(a) $13\,\hat{k}, \sqrt{13}$ length units.
(b) $-13\,\hat{k}, \sqrt{13}$ length units.
(c) $13\,\hat{k}, 2\sqrt{13}$ length units.
(d) $-3\,\hat{k}, 3\sqrt{13}$ length units.

---

15 If $\overrightarrow{F_1}, \overrightarrow{F_2}$ are two horizontal forces act at two points A (1 , 3) , B (0 , 5) respectively and form a couple its moment $20\,\hat{k}$, then $\overrightarrow{F_1}$ could be ....

(a) (10 , 0)
(b) (11 , 0)
(c) (20 , 0)
(d) (0 , – 10)

---

16 Two forces $\overrightarrow{F_1} = (2, -5)$, $\overrightarrow{F_2}$ act at the two points A (2 , ℓ) , B (ℓ , 3) respectively. If the two forces form a couple its moment is $-7\,\hat{k}$, then ℓ = ...

(a) –1
(b) zero
(c) 1
(d) 2

---

17 If a set of forces form a couple and there are 3 points A , B and C lie in the plane of the forces such that $\overrightarrow{M_A} + \overrightarrow{M_B} = 22\,\hat{k}$, then $\overrightarrow{M_C}$ = ...

(a) $22\,\hat{k}$
(b) $-13\,\hat{k}$
(c) $11\,\hat{k}$
(d) $-11\,\hat{k}$

---

18 If $\overrightarrow{M_1}$ and $\overrightarrow{M_2}$ are two couples in equilibrium and $\overrightarrow{M_1} = 20\,\hat{k}$, then $\overrightarrow{M_1} - \overrightarrow{M_2}$ = ...

(a) $\overrightarrow{O}$
(b) $-40\,\hat{k}$
(c) $20\,\hat{k}$
(d) $40\,\hat{k}$

---

19 Two couples are equivalent , the algebraic measures of their moments $M_1 = x^2$ N.m. , $M_2 = (6x - 9)$ N.m. , then x = ...

(a) – 3
(b) zero
(c) 2
(d) 3

---

20 $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two forces form a couple where $\overrightarrow{F_1} = 6\,\hat{i} + 8\,\hat{j}$ and acts at the point A (0 , 5) , then the equation of the line of action of the force $\overrightarrow{F_2}$ could be ....

(a) $4x - 3y = 1$
(b) $3y = 4x + 15$
(c) $16x + 12y = 3$
(d) $4x + 3y = 0$

21 Two forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ form a couple, the algebraic measure of its moment is 30 moment units and two forces $\overrightarrow{F_2}$ and $\overrightarrow{F_3}$ form a couple, the algebraic measure of its moment is – 40 moment units, then the two forces $\overrightarrow{F_1}$, $\overrightarrow{F_3}$ ....

(a) form a couple, the algebraic measure of its moment is 10 moment units.

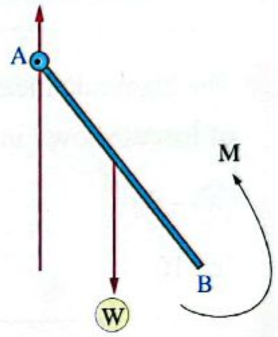
(b) form a couple, the algebraic measure of its moment is – 10 moment units.

(c) are parallel and act in the same direction.

(d) are in equilibrium.

---

22 The opposite figure shows a rod $\overline{AB}$ which is kept in equilibrium. It is hinged at A and the magnitude of the external couple of moment M, then the direction of the reaction of the hinge at A is ....

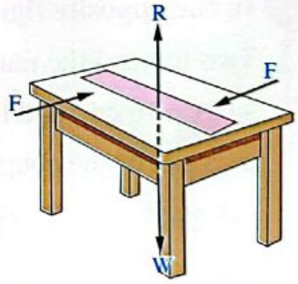


(a) $\longrightarrow$ (b) $\longleftarrow$

(c) $\uparrow$ (d) $\nearrow$

---

23 The opposite figure represents a ruler has weight (w), placed on a smooth horizontal table. Two coplanar parallel forces acting on it in opposite directions (– F, F), so the ruler is ....



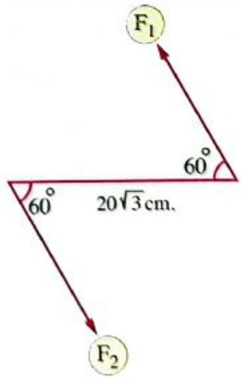
(a) at rest and in equilibrium. (b) moving by translation.

(c) moving by rotation. (d) about to move.

---

24 **In the opposite figure :**

$F_1 = 7$ newton and $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ form a couple, then the algebraic measure of moment of the couple = ... newton.cm.



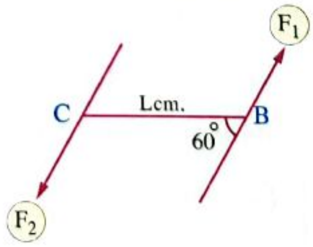
(a) 210 (b) $70\sqrt{3}$

(c) $140\sqrt{3}$ (d) 140

---

25 **In the opposite figure :**

$F_1 = 8$ newton, the two forces $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ form a couple whose moment norm equals 240 newton. cm., then L = ... cm.

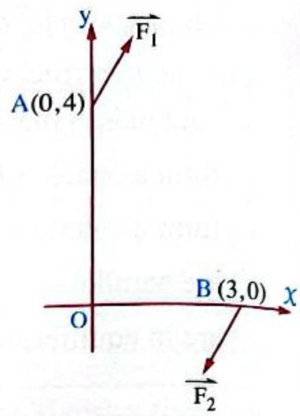


(a) 30 (b) $30\sqrt{3}$

(c) $20\sqrt{3}$ (d) $15\sqrt{3}$

26 **In the opposite figure :**

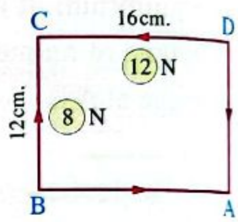
$\overrightarrow{F_1} = k\hat{i} + 2\hat{j}$, the equation of the line of action of $\overrightarrow{F_2}$ is $y = 2x - 6$, if the two forces $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ form a couple , then the moment vector of this couple equals ....



(a) $-10\hat{k}$ (b) $10\hat{k}$

(c) $-6\hat{k}$ (d) $-8\hat{k}$

27 The algebraic measure of the moment of the couple of the system of forces shown in the figure in newton. cm. equals ....

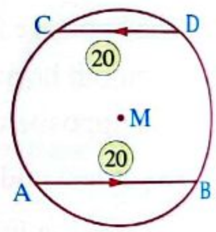


(a) -96 (b) -16

(c) 16 (d) 96

28 **In the opposite figure :**

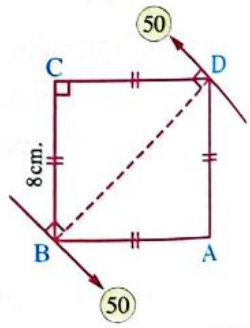
Two forces , the magnitude of each is 20 kg.wt. , DC = 12 cm. , BA = 16 cm. and the radius length = 10 cm. , then the algebraic measure of the couple = ... kg.wt.cm.



(a) 280 (b) 20 (c) 160 (d) 120

29 **In the opposite figure :**

The algebraic measure of the moment of the couple that the magnitude of each of its forces is 50 gm.wt. is .... gm.wt.cm.

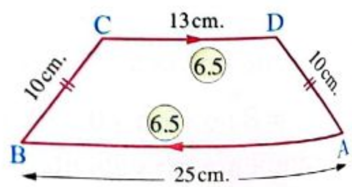


(a) $200\sqrt{2}$ (b) $800\sqrt{2}$

(c) 400 (d) $400\sqrt{2}$

30 **In the opposite figure :**

If $\overline{DC} \parallel \overline{AB}$. Two forces each of magnitude 6.5 N. acts along $\overrightarrow{AB}$, $\overrightarrow{CD}$, then the algebraic measure of the moment of the couple = ... N.cm.

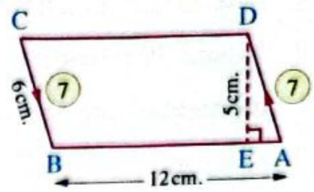


(a) -48 (b) -50

(c) -52 (d) -56

31 **In the opposite figure :**

ABCD is a parallelogram two forces magnitude of each is 7 newton acts along $\overrightarrow{AD}$, $\overrightarrow{CB}$ then the algebraic measure of the moment of the couple = ... N.cm.



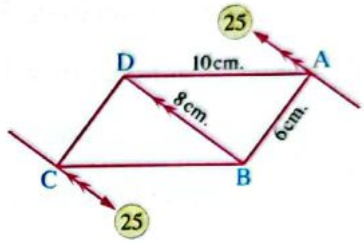
(a) 35 (b) 70

(c) 84 (d) 91

---

32 **In the opposite figure :**

ABCD is a parallelogram , AB = 6 cm.
, BD = 8 cm. , AD = 10 cm.
If the two forces (25 , 25) form a couple
, then the magnitude of its moment = ... N. cm.



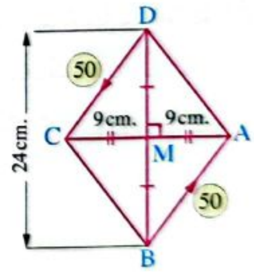
(a) 250 (b) 300

(c) 400 (d) 500

---

33 **In the opposite figure :**

ABCD is a rhombus two forces each of magnitude 50 newton acts along $\overrightarrow{BA}$, $\overrightarrow{DC}$, then the algebraic measure of the moment of the couple = ... N.cm.



(a) 450 (b) 720

(c) 900 (d) 1200

---

34 ABCD is a parallelogram in which AB = 6 cm. , BC = 8 cm. and m (∠ A) = 60°. Forces of magnitude 8 , 10 , 8 , 10 newton act along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$, $\overrightarrow{AD}$ respectively , then the system equivalent a couple its magnitude = ... N.cm.

(a) $\sqrt{3}$ (b) $2\sqrt{3}$ (c) $3\sqrt{3}$ (d) $4\sqrt{3}$

---

35 ABCD is a square , whose side length is 18 cm. H and O ∈ $\overline{BD}$, where m (∠ CHD) = m (∠ AOB) = 60° , then the magnitude of the moment of the couple where the measure of each force is 10 kg.wt. and act along $\overrightarrow{OA}$ and $\overrightarrow{HC}$ equals .... kg.wt.cm.

(a) $20\sqrt{2}$ (b) $50\sqrt{2}$ (c) $90\sqrt{2}$ (d) $105\sqrt{2}$

36 ABCD is a rectangle where AB = 12 cm. , AD = 5 cm. Two equal forces of magnitude 39 and 39 newton act at A and C in direction of $\overrightarrow{BD}$ and $\overrightarrow{DB}$. Then the magnitude of the moment of the couple = ... N.cm.

(a) 120 (b) 240 (c) 300 (d) 360

---

37 Forces of magnitudes 4 , 3 , 4 , 3 N act along the sides of a square ABCD in direction of $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DA}$ respectively, if the length of the square side is ℓ , then the resultant of these forces equivalent to ....

(a) force of magnitude $5\sqrt{2}$ and passes through the centre of the square.

(b) force of magnitude 14 and passes through A

(c) a couple, the norm of its moment is $7\ \ell$

(d) a couple, the norm of its moment is ℓ

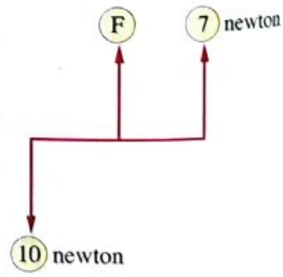
---

38 Two couples act on a body, the magnitude of a force of the first couple is 20 kg.wt. , its arm length = $\frac{1}{2}$ m. and the direction of its rotation is anticlockwise, the magnitude of a force of the second couple is 30 kg.wt. , its arm length = 1 m. and the direction of its rotation is clockwise, then the algebraic measure of the moment of the resultant couple = ... kg.wt.m.

(a) 20 (b) – 20 (c) 40 (d) 10

---

39 If the opposite system is equivalent to a couple , then F = ... N.

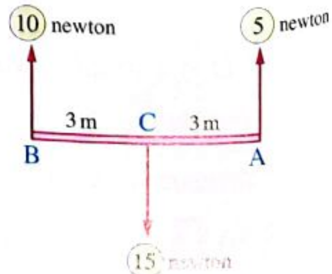


(a) 3 (b) 7

(c) 10 (d) 17

---

40 The algebraic measure of the moment of the couple of the set of forces shown in the figure in newton. m. equals ....



(a) – 150 (b) – 30

(c) – 15 (d) 135

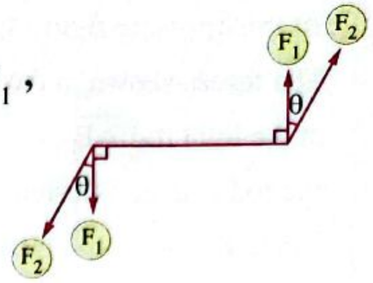
41 **In the opposite figure :**

Two forces $\overrightarrow{F_1}$, $-\overrightarrow{F_1}$ form a couple its moment magnitude is M_1 ,

two forces $\overrightarrow{F_2}$, $-\overrightarrow{F_2}$ form a couple its moment

magnitude is M_2 If $\|\overrightarrow{F_1}\| = \|\overrightarrow{F_2}\|$ and $\theta \in]0 , \frac{\pi}{2}[$

, then ....



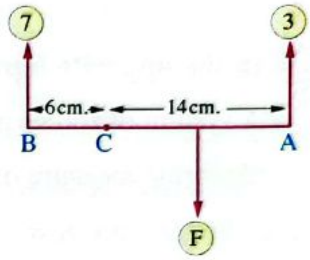
(a) $M_1 = M_2$ (b) $M_1 > M_2$ (c) $M_1 < M_2$ (d) $M_1 = M_2 \sin\theta$

---

42 **In the opposite figure :**

Three forces, measured in newton act on a rod $\overline{AB}$

If the set form a couple , then ....



(a) F = 10 N. and acts at C

(b) F = 10 N. and acts at B

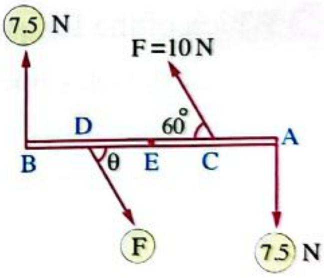
(c) F = 4 N. and acts at A

(d) F = 10 N. and acts at any point on the rod except C.

---

43 **In the opposite figure :**

If $\overline{AB}$ is a light rod of length 30 cm. , (E) is its midpoint , then the length of $\overline{CD}$ in case of the rod equilibrium horizontally equals .... cm.

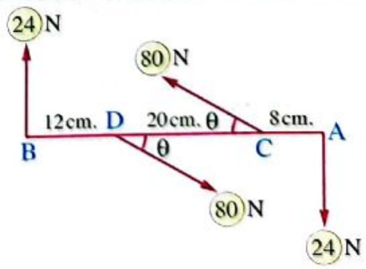


(a) 10 (b) 15

(c) $10\sqrt{3}$ (d) $15\sqrt{3}$

---

44 If $\overline{AB}$ is a rod in equilibrium under action of set of forces shown in the figure , then : $\sin\theta =$ ....



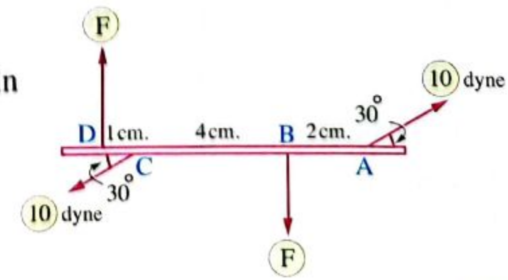
(a) $\frac{5}{6}$ (b) $\frac{4}{5}$

(c) $\frac{3}{5}$ (d) $\frac{1}{2}$

---

45 **In the opposite figure :**

Four forces represents two couples , if the system is in equilibrium , then F = ... dyne



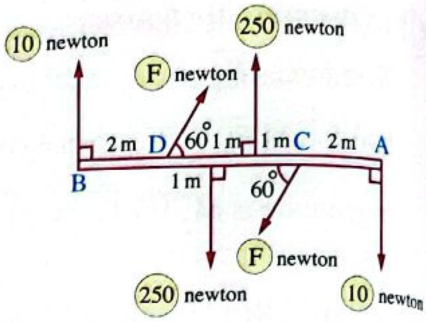
(a) 5 (b) 6

(c) 10 (d) $10\sqrt{2}$

46 **In the opposite figure :**

The forces shown in the figure act at the light rod $\overline{AB}$ the rod is in equilibrium.

, then F = ... Newton.



(a) 40 (b) $40\sqrt{3}$

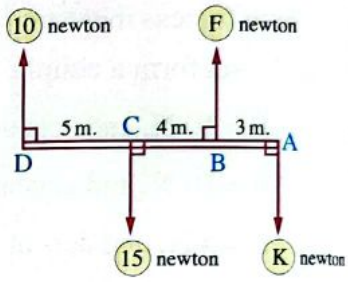
(c) 50 (d) $50\sqrt{3}$

---

47 **In the opposite figure :**

A system of forces acting on rod $\overline{AD}$ forms the couple of the algebraic measure of its moments is equal to – 75 newton.m.

, then the F + K = ... N.



(a) 15 (b) 20

(c) 35 (d) 40

---

48 Which of the following pairs of couples are equivalent ?

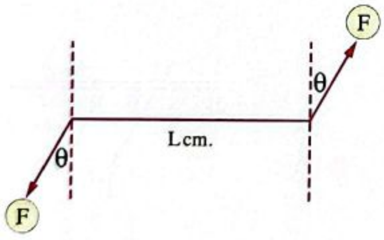


Figure (1)

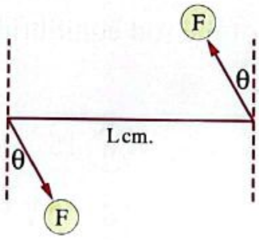


Figure (2)

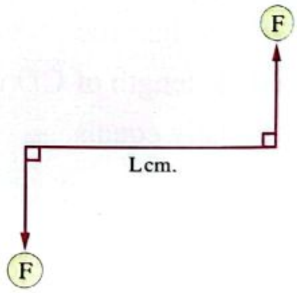


Figure (3)

(a) Figure (1) , (2) (b) Figure (2) , (3)

(c) Figure (1) , (3) (d) All figures

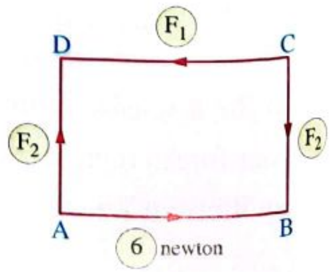
---

49 **In the opposite figure :**

ABCD is a rectangle in which AB = 12 cm.

, BC = 8 cm. The forces of magnitudes and directions as shown in the figure act on it to form two equilibrium couples

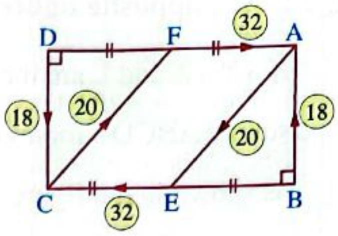
, then $F_1 - F_2 =$ .... newton.



(a) – 4 (b) – 2 (c) 2 (d) 4

50 **In the opposite figure :**

ABCD is a rectangle. E and F are the midpoints of $\overline{BC}$ and $\overline{AD}$ respectively. AB = 6 cm. and BC = 16 cm.
If the acting forces their magnitudes in newton and their magnitudes and directions are shown in the figure.
, then forces are ....



(a) in equilibrium
(b) equivalent to a couple its moment of magnitude 288 N.cm.
(c) equivalent to a couple its moment of magnitude 96 N.cm.
(d) equivalent to a couple its moment of magnitude 192 N.cm.

---

51 ABCD is a rectangle in which AB = 30 cm. , BC = 40 cm. forces of magnitudes 15 , 30 , 15 , 30 newton act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{DA}$ respectively two forces each of magnitude F acting at A and C perpendicular to $\overline{AC}$ and the system is in equilibrium then F = ... newton.

(a) 5 (b) 6 (c) 7 (d) 8

---

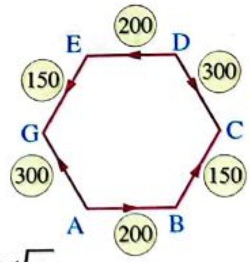
52 ABCDEO is a regular hexagon of side length 12 cm. Forces of magnitudes 3 , 7 , 10 gm.wt. act along $\overrightarrow{AB}$, $\overrightarrow{ED}$, $\overrightarrow{CO}$ respectively. Then the system of forces is equivalent to a couple the magnitude of its moment = ... gm.wt.cm.

(a) $12\sqrt{3}$ (b) $16\sqrt{3}$ (c) $18\sqrt{3}$ (d) $24\sqrt{3}$

---

53 **In the opposite figure :**

ABCDEG is a regular hexagon with side length 40 cm. Forces of magnitudes and directions as shown in the figure act on it , then the system is equivalent to a couple , the norm of its moment = ... N.cm.

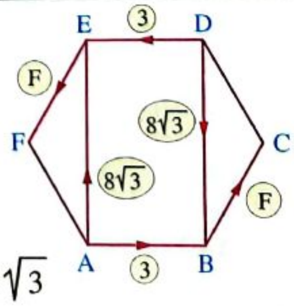


(a) $2000\sqrt{3}$ (b) $3000\sqrt{3}$ (c) $4000\sqrt{3}$ (d) $5000\sqrt{3}$

---

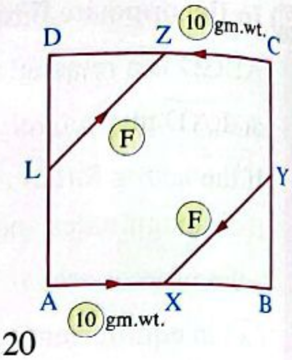
54 **In the opposite figure :**

ABCDEF is a regular hexagon of side length 10 cm. The forces have magnitudes (in gm.wt.) and directions shown in the figure are in equilibrium , then F = ... gm.wt.



(a) 3 (b) 5 (c) 8 (d) $8\sqrt{3}$

55 **In the opposite figure :**

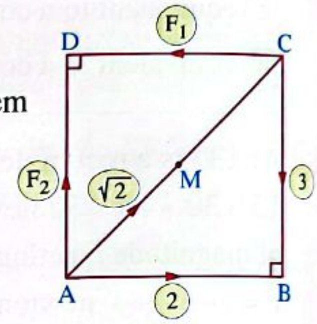


X , Y , Z and L are the midpoints of the sides of the square ABCD , forces of magnitudes and drections as shown in the figure act on it to be in equilibrium , then F = ... gm.wt.

(a) $5\sqrt{2}$ (b) 10 (c) $10\sqrt{2}$ (d) 20

---

56 **In the opposite figure :**



ABCD is a square the given forces are measured in dyne , if the system of forces is in equilibrium, then $F_1 - F_2 =$ .... dyne.

(a) 3 (b) 2

(c) 1 (d) -1

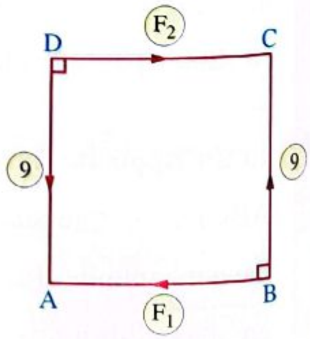
---

57 ABCD is a square of side length 1 m. two forces each of magnitude 4 kg.wt. act along $\overrightarrow{AB}$ and $\overrightarrow{CD}$. Also two other forces each of magnitude (F) kg.wt. act outside the square at D and B so that the first force makes an angle of measure 15° with $\overrightarrow{DA}$, the second force makes an angle of measure 15° with $\overrightarrow{BC}$, then the value of F if the couple formed by the first two forces is equivalent to the couple formed by the last two forces = ... kg.wt.

(a) $4\sqrt{6}$ (b) $\frac{4\sqrt{3}}{3}$ (c) $\frac{4\sqrt{6}}{3}$ (d) $\frac{3\sqrt{6}}{4}$

---

58 **In the opposite figure :**



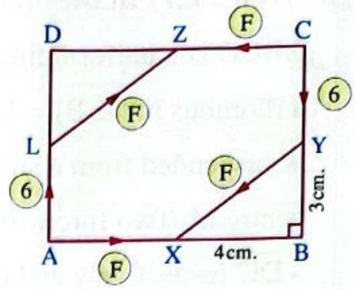
ABCD is a square of side length 4 cm. , the forces of magnitudes and directions as shown in the figure act in its sides. If the system is equivalent to a couple , the magnitude of its moment = 20 newton.cm. , then $F_1 = F_2 =$ ....

(a) 4 or 14 (b) 14 or 56

(c) 4 or 56 (d) 56 or 32

59 **In the opposite figure :**

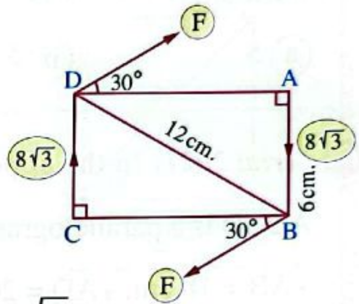
X , Y , Z , L are the midpoints of the sides of the rectangle ABCD , the forces of magnitudes and directions shown in the figure are in equilibrium , then F = ... N.



ⓐ 24 ⓑ 32
ⓒ 40 ⓓ 48

60 ***(1st Session 2021)*** **In the opposite figure :**

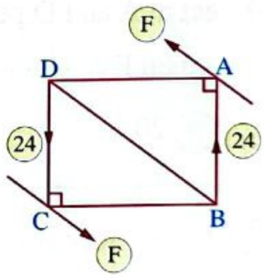
ABCD is a rectangle in which AB = 6 cm. and BD = 12 cm. , the shown forces act on it , if the couple formed from the two forces $8\sqrt{3}$, $8\sqrt{3}$ gm.wt. is equivalent to the couple formed from the two forces F , F gm.wt. , then F = ... gm.wt.



ⓐ 8 ⓑ $4\sqrt{3}$ ⓒ 4 ⓓ $8\sqrt{3}$

61 ***(2nd Session 2021)*** **In the opposite figure :**

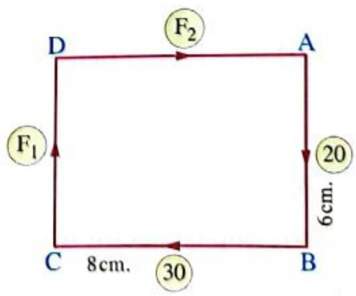
ABCD is a rectangle in which AB = 6 cm. , BC = 8 cm. , the two forces of magnitudes F , F newton act at the two points A and C and parallel to $\overleftrightarrow{BD}$ to form a couple (as the figure shown) , if another two forces of magnitudes 24 , 24 newton act along $\overrightarrow{BA}$ and $\overrightarrow{DC}$ to form a couple equivalent to the first couple , then F = ... newton.



ⓐ 14.4 ⓑ 20 ⓒ 25 ⓓ 19.2

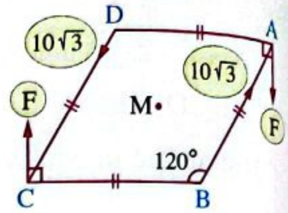
62 ***(2nd Session 2021)*** **In the opposite figure :**

ABCD is a rectangle in which AB = 6 cm. , BC = 8 cm. the forces (measured in newton) act as shown in the figure , if a force of magnitude F newton is added to each force where F ≠ zero , the forces became completely represented by the sides of the rectangle , then the system is equivalent to a couple , the algebraic measure of its moment = ... newton.cm.



ⓐ 480 ⓑ – 480 ⓒ 300 ⓓ – 300

63 ***(Trial 2021)*** **In the opposite figure :**

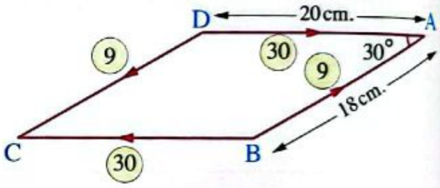


ABCD is a uniform fine lamina in form of a rhombus m (∠ B) = 120° , the lamina is suspended from a small hole near to its centre M. Two forces $10\sqrt{3}$ N. and $10\sqrt{3}$ N. acts in $\overrightarrow{BA}$, $\overrightarrow{DC}$ respectively and two forces of magnitude F , F newton act at A and C perpendicular to $\overline{AD}$, $\overline{BC}$ respectively as shown in the figure. If the lamina is in equilibrium , then F = ... N.

ⓐ 5 ⓑ $5\sqrt{3}$ ⓒ $10\sqrt{3}$ ⓓ 10

---

64 ***(Trial 2021)*** **In the opposite figure :**



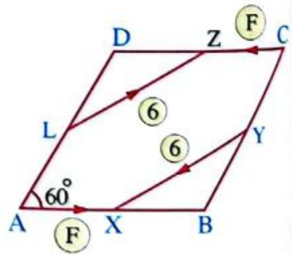
ABCD is a parallelogram , m (∠ A) = 30° , AB = 18 cm. , AD = 20 cm. Forces act as shown in the figure to form a resultant couple.

If two forces of magnitudes F and F gm.wt. act at A and D perpendicular to $\overline{AD}$ and form a couple equivalent to the previous one , then F = ... gm.wt.

ⓐ 20 ⓑ 18 ⓒ 10 ⓓ 9

---

65 **In the opposite figure :**

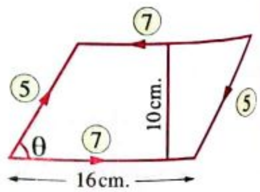


X , Y , Z , L are the midpoints of sides in rhombus ABCD , m (∠ A) = 60°. The forces have magnitudes and directions shown in the figure are in equilibrium , then F = ... N.

ⓐ 2 ⓑ 3 ⓒ $2\sqrt{3}$ ⓓ 6

---

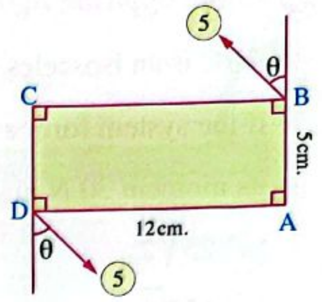
66 The opposite figure shows a lamina in form of a parallelogram. Two couples act on it , the algebraic measure of the moment of the resultant couple equals 30 N.cm. where the given forces are in newton , then θ = ...



ⓐ 30° ⓑ 45° ⓒ 60° ⓓ 90°

67 **In the opposite figure :**

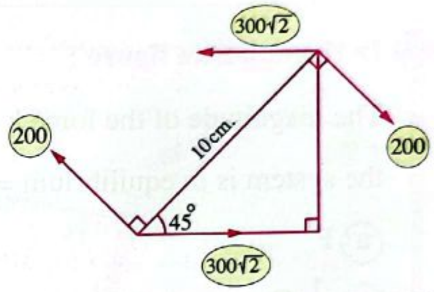
ABCD is a rectangle in which AB = 5 cm. , BC = 12 cm. , the algebraic measure of the couple moment produced by the two forces 5 , 5 newton shown in the figure equals 65 newton.cm. , then tan θ = ...



(a) undefined.
(b) zero
(c) $\frac{5}{12}$
(d) $\frac{4}{3}$

68 **In the opposite figure :**

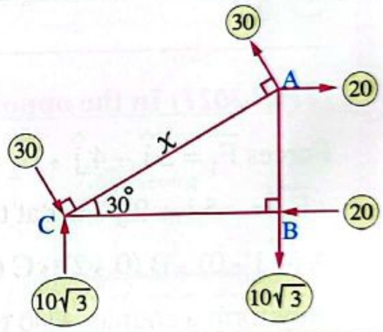
If the given forces in newton , then the algebraic measure of the resultant couple moment equals .... newton. cm.



(a) – 3000
(b) – 2000
(c) – 1000
(d) 1000

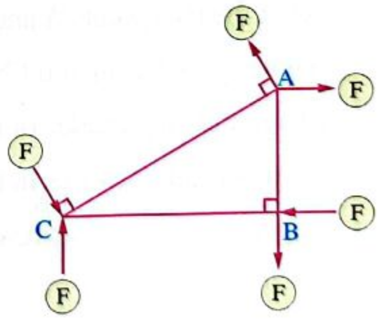
69 **In the opposite figure :**

If the algebraic measure of the moment of the resultant couple equals 100 N. cm. , then X = ... cm.



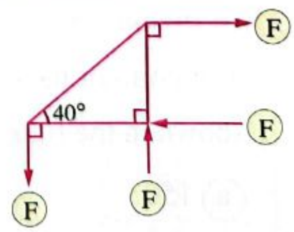
(a) 10
(b) 20
(c) 25
(d) 30

70 The set of forces in the opposite figure is ....



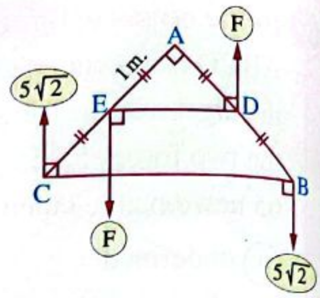
(a) in equilibrium.
(b) equivalent to a force.
(c) equivalent to a couple , the algebraic measure of its moment is positive.
(d) equivalent to a couple , the algebraic measure of its moment is negative.

71 The set of forces given in the opposite figure ....



(a) are in equilibrium
(b) equivalent to a force
(c) equivalent to a couple the algebraic measure of its moment is positive.
(d) equivalent to a couple the algebraic measure of its moment is negative.

72 In the opposite figure :



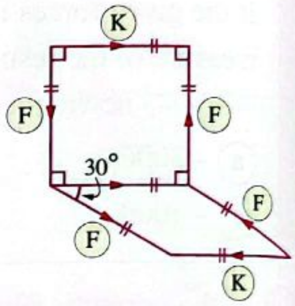
ABC is an isosceles right angled triangle AB = AC = 2 m.

If the system form a couple , the algebraic measure of its moment 30 N.m. , then F = ... N.

(a) $25\sqrt{2}$
(b) $20\sqrt{2}$
(c) $15\sqrt{2}$
(d) $10\sqrt{2}$

---

73 In the opposite figure :

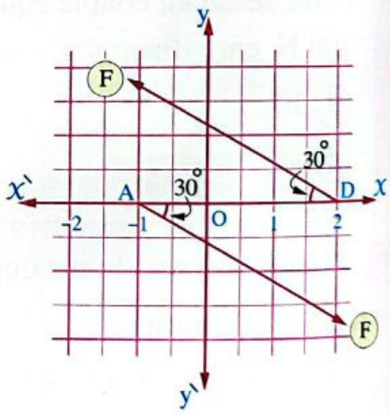


The magnitude of the force k which makes the system is in equilibrium = ...

(a) F
(b) 2 F
(c) $\frac{1}{2}$ F
(d) $\sqrt{3}$ F

---

74 *(Trial 2021)* In the opposite figure :

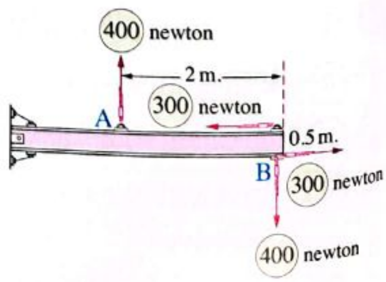


Forces $\overrightarrow{F_1} = 2\hat{i} - 4\hat{j}$, $\overrightarrow{F_2} = 3\hat{i} - 5\hat{j}$, $\overrightarrow{F_3} = -5\hat{i} + 9\hat{j}$, act at the points A (– 1 , 0) , B (0 , 2) , C (1 , – 2) and they form a couple. Also two forces of magnitudes F , F act at the two points A and D as shown in the figure if the whole system is in equilibrium (given the magnitudes of the forces are given in gm.wt. and act in a rigid body lies in the x y-plane) , then F = ... gm.wt.

(a) $\sqrt{3}$
(b) 3
(c) 2
(d) $\sqrt{2}$

---

75 In the opposite figure :

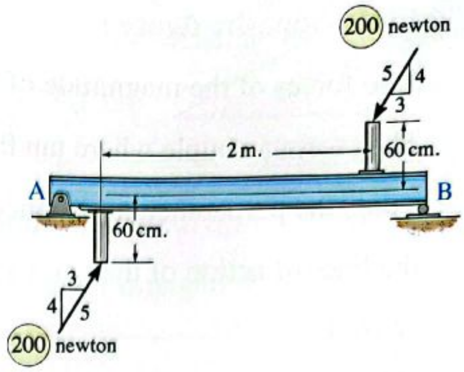


The norm of the moment of the couple of the forces shown in the figure in newton. m. equals ....

(a) 150
(b) 650
(c) 800
(d) 950

76 In the opposite figure :

The norm of the moment of the couple of the forces shown in the figure in newton.m. equals ....



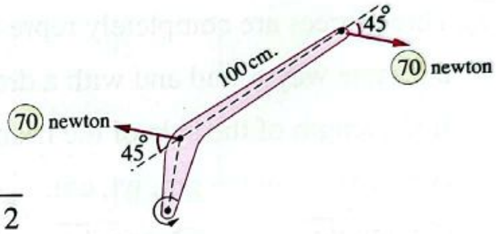
(a) 144 (b) 176

(c) 320 (d) 464

---

77 In the opposite figure :

The algebraic measure of the moment of the couple in newton.cm equals ....



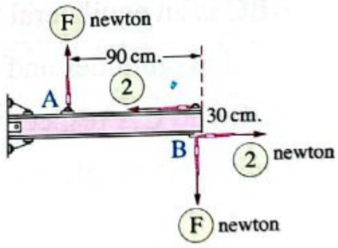
(a) – 7000 (b) $-3500\sqrt{2}$

(c) $3500\sqrt{2}$ (d) 7000

---

78 In the opposite figure :

If the moment of the resultant couple = – 1.5 N.m. , then F = ... N.



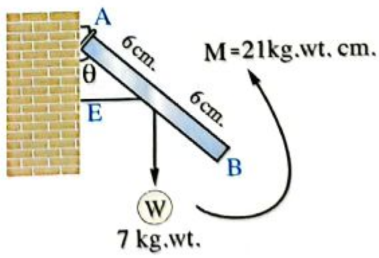
(a) $\frac{7}{3}$ (b) $\frac{41}{60}$

(c) $\frac{2}{3}$ (d) $\frac{13}{20}$

---

79 In the opposite figure :

$\overline{AB}$ is a uniform rod of weight 7 kg.wt hinged at A to a vertical wall and kept in equilibrium by a couple its moment 21 kg.wt. cm. , then :



First : R = ... kg.wt

(a) 3 (b) 7 (c) 12 (d) 21

Second : θ = ...

(a) 15° (b) 30° (c) 45° (d) 60°

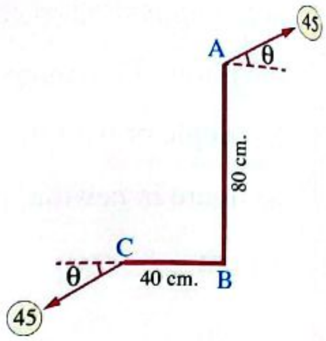
80 **In the opposite figure :**

Two forces of the magnitude of each 45 N.

They form a couple where $\tan\theta = \frac{3}{4}$

, then the perpendicular distance between

the lines of action of the two forces = ... m.



(a) 0.4 (b) 0.25

(c) 0.5 (d) 0.65

---

81 Three forces are completely represented by the sides of an equilateral triangle ABC , taken the same way round and with a drawing scale 1 cm. to 2 gm. wt.

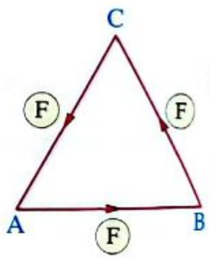
If the length of the side of the triangle is 30 cm. , then the magnitude of the resulting couple = ... gm. wt. cm.

(a) $450\sqrt{3}$ (b) $900\sqrt{3}$ (c) $1200\sqrt{3}$ (d) $225\sqrt{3}$

---

82 **In the opposite figure :**

ABC is an equilateral triangle, of side length L cm. If forces of equal magnitudes and each of magnitude F newton , act along $\overrightarrow{AB}$, $\overrightarrow{BC}$ and $\overrightarrow{CA}$ respectively , then the magnitude of moment of the equivalent couple = ... newton. cm.



(a) $\frac{\sqrt{3}}{2} L^2 F$ (b) $2\sqrt{3}\,LF$ (c) $\sqrt{3}\,LF$ (d) $\frac{\sqrt{3}}{2}\,LF$

---

83 The magnitude of the couple moment produced by 3 forces represented completely by sides of triangle ABC taken in one cyclic order such that the force unit represents lenght unit , BC = 5 cm. , CA = 5 cm. , AB = 8 cm. is .... moment unit.

(a) 12 (b) 24 (c) 36 (d) 16

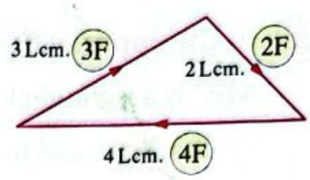
---

84 Three forces of magnitudes 25 , 30 , 25 newtons are represented completely by the three directed line segments $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CA}$ respectively of ΔABC in which BC = 45 cm.

, then the magnitude of the moment of the couple which is equivalent to the system of forces = ... newton.cm.

(a) 800 (b) 900 (c) 1000 (d) 1100

85 The set of forces given in the opposite figure ....



(a) are in equilibrium.

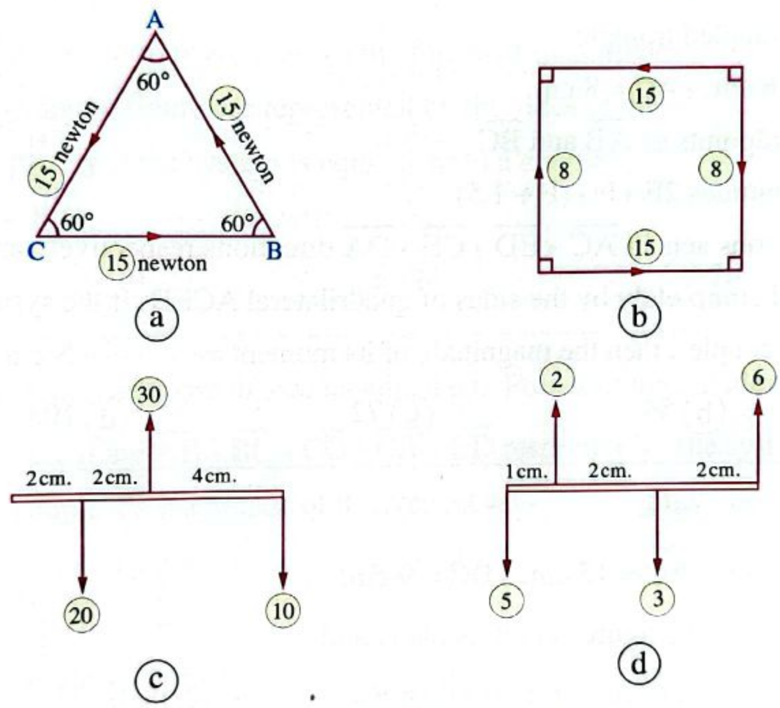
(b) equivalent to a force.

(c) equivalent to a couple the algebraic measure of its moment is positive.

(d) equivalent to a couple , the algebraic measure of its moment is negative.

---

86 The system of forces which does not represent a couple is ....



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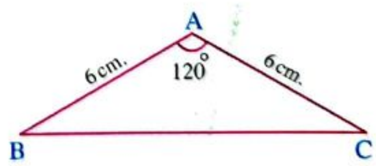
87 Which of the following sets of forces if they act along the sides of the triangle ABC and in one cyclic order they can produce a couple ?



(a) 10 , 10 , 10 newton.

(b) 6 , 8 , 10 newton.

(c) 12 , 12 , $12\sqrt{2}$ newton.

(d) 15 , 15 , $15\sqrt{3}$ newtons.

---

88 ABC is a triangle in which AB = 7 cm. , BC = 8 cm. , m ($\angle$ ABC) = 120°. Forces of magnitudes 17.5 , 20 , 32.5 newton act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CA}$ respectively. The system of these forces is equivalent to a couple , the magnitude of its moment = ... N.cm.

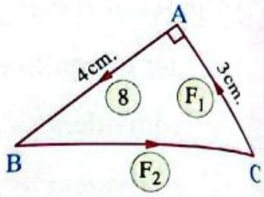
(a) $50\sqrt{3}$

(b) $60\sqrt{3}$

(c) $70\sqrt{3}$

(d) $80\sqrt{3}$

89 **In the opposite figure :**

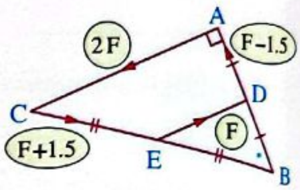


ABC is a right-angled triangle at A , AB = 4 cm.
, AC = 3 cm. and the shown forces are measured in newtons and is represented completely by the sides of Δ ABC if the system of forces is equivalent to a couple , then $F_1 + F_2 =$ .... newton.

ⓐ 6 ⓑ 10 ⓒ 4 ⓓ 16

---

90 ***(Trial 2021)*** **In the opposite figure :**

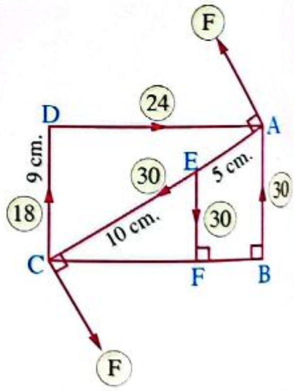


ABC is a right-angled triangle at $\angle$ A , AB = 6 cm. , AC = 8 cm.
D and E are midpoints of $\overline{AB}$ and $\overline{BC}$
Forces of magnitudes 2F , F , (F + 1.5)
, (F − 1.5) newtons acts in $\overrightarrow{AC}$, $\overrightarrow{ED}$, $\overrightarrow{CE}$, $\overrightarrow{DA}$ directions respectively and are represented completely by the sides of quadrilateral ACED. If the system is equivalent to a couple , then the magnitude of its moment = ... N.cm.

ⓐ 36 ⓑ 54 ⓒ 72 ⓓ 108

---

91 **In the opposite figure :**

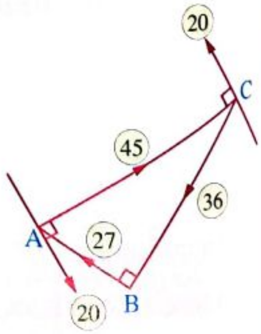


ABCD is a rectangle AC = 15 cm. , DC = 9 cm.
the forces shown in the figure act on its plane and the rectangle becomes in equilibrium , then F = ... N. their.

ⓐ 10 ⓑ 8
ⓒ 7.5 ⓓ 6.4

---

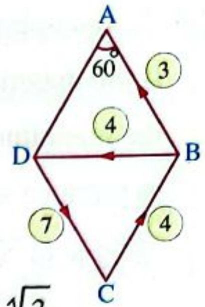
92 ***(1st Session 2021)*** **In the opposite figure :**



ABC is a right-angled triangle at B in which AB = 9 cm.
, BC = 12 cm. , forces of magnitudes 27 , 45 and 36 newton act in $\overrightarrow{BA}$, $\overrightarrow{AC}$, $\overrightarrow{CB}$ respectively and the forces 20 , 20 newton act at A , C in directions perpendicular to $\overline{AC}$ as shown in the figure. If the system is equivalent to a couple , then the norm of moment of the resultant couple = ... newton.cm.

ⓐ 24 ⓑ 624 ⓒ 48 ⓓ 948

93 *(2nd Session 2021)* **In the opposite figure :**

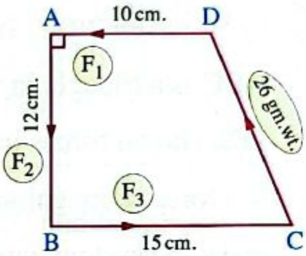


ABCD is a rhombus of side length 6 cm. , m (∠ A) = 60° , the forces of magnitudes 3 , 7 , 4 and 4 newton act along $\overrightarrow{BA}$, $\overrightarrow{DC}$, $\overrightarrow{CB}$, $\overrightarrow{BD}$ respectively , if the system is equivalent to a couple , then the norm of its moment = ... newton.cm.

(a) $10\sqrt{3}$ (b) $15\sqrt{3}$ (c) $25\sqrt{3}$ (d) $21\sqrt{3}$

---

94 **In the opposite figure :**



ABCD is a right-angled trapezium at A , the forces of magnitudes in gm.wt. shown in the figure are represented by the sides of the trapezium completely if the system is equivalent to a couple , then $F_1 + F_2 + F_3$ = ... gm.wt.

(a) 74 (b) 30 (c) 24 (d) 20

---

95 ABCDEO is a regular hexagon of side length 14 cm. Forces of magnitudes 6 , 6 , 8 , $6\sqrt{3}$, 8 gm.wt. act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CO}$, $\overrightarrow{CA}$, $\overrightarrow{ED}$ respectively. The system of forces is equivalent to a couple the magnitude of its moment = ... gm.wt.cm.

(a) $10\sqrt{3}$ (b) $12\sqrt{3}$ (c) $14\sqrt{3}$ (d) $16\sqrt{3}$

---

96 ABCD is a rectangle , in which AB = 9 cm. , BC = 24 cm. H , F are the midpoint of $\overline{BC}$, $\overline{AD}$ respectively. Forces of magnitudes 18 , 48 , 30 , 24 gm.wt. act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CF}$ and $\overrightarrow{FA}$ respectively. two forces F , F act along $\overrightarrow{HA}$, $\overrightarrow{FC}$ such that the two forces will be in equilibrium with the given forces then F = ... gm.wt.

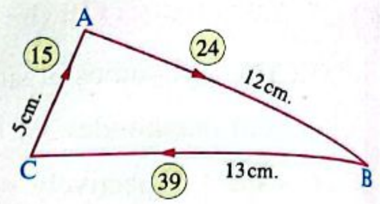
(a) 40 (b) 60 (c) 70 (d) 90

---

97 ABCD is a trapezium in which $\overline{AD}$ // $\overline{BC}$, $\overline{AB}$ is perpendicular to them. E is the projection of D on $\overline{BC}$, CB = 15 cm. , BA = 8 cm. , AD = 9 cm. Forces of magnitudes 12 , 18 , 20 , 12 , 34 newton act along $\overrightarrow{AB}$, $\overrightarrow{AD}$, $\overrightarrow{DC}$, $\overrightarrow{ED}$, $\overrightarrow{CA}$ respectively. Then the system of forces is equivalent to a couple and the magnitude of its moment = ... N.cm.

(a) 27 (b) 36 (c) 45 (d) 54

98 **In the opposite figure :**



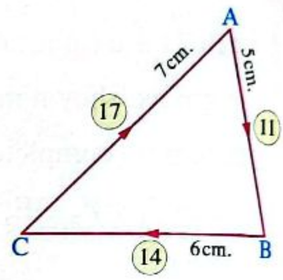
If the magnitudes of the forces are given in newton then the magnitude of the force should be added to the system to produce a couple equals ....

(a) 2 N in $\overrightarrow{AB}$ direction. (b) 12 N in $\overrightarrow{BA}$ direction.

(c) 12 N in $\overrightarrow{AB}$ direction. (d) 36 N in $\overrightarrow{AB}$ direction.

---

99 *(1st Session 2021)* **In the opposite figure :**



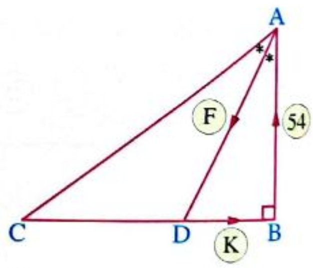
ABC is a triangle in which AB = 5 cm. , BC = 6 cm. , AC = 7 cm. , the shown forces in the figure measured in newton.

If a force of magnitude F newton is added to each force to make the system equivalent to a couple , then the algebraic measure of the moment couple = ... newton.cm.

(a) $-36\sqrt{6}$ (b) $36\sqrt{6}$ (c) 72 (d) -72

---

100 **In the opposite figure :**



ABC is a right angled triangle at B ,

$\overrightarrow{AD}$ bisects ∠ A , AB = 18 cm. , AC = 30 cm.

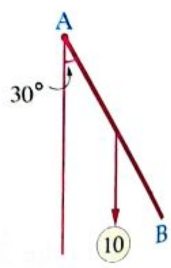
The forces shown in the figure form a couple

, then $\frac{F}{K}$ = ...

(a) 1 (b) $\sqrt{3}$ (c) $\sqrt{5}$ (d) 5

---

101 *(Trial 2021)* **In the opposite figure :**



$\overline{AB}$ is a uniform rod of length 2 m. and weight 10 kg.wt. acts at its midpoint. The rod is hinged at A to a vertical wall. A couple acts on the rod perpendicular to vertical plane passes through the rod and the magnitude of its moment = 10 kg.wt.m. , then the rod is in equilibrium when it makes an angle of measure 30° to the vertical when a body of mass .... kg. is suspended from the other end (B)

(a) 5 (b) 10 (c) $5\sqrt{3}$ (d) $10\sqrt{3}$

102 Two forces $\overrightarrow{F_1} = 30\,\hat{i} - 40\,\hat{j}$, $\overrightarrow{F_2} = -30\,\hat{i} + 40\,\hat{j}$ (measured in newton) and the distance between them is 3 meters , then the magnitude of the moment of the forces about the point $(-4 , 1)$ is .... newton.metre.

(a) 50 (b) 130 (c) 140 (d) 150

---

103 Two forces form a couple, the magnitude of each is 30 N. and the magnitude of the couple is 120 N. cm. If the magnitude of each force is increased by 5 N. , then the magnitude of the produced couple equals .... N. cm.

(a) 140 (b) 130 (c) 120 (d) 110

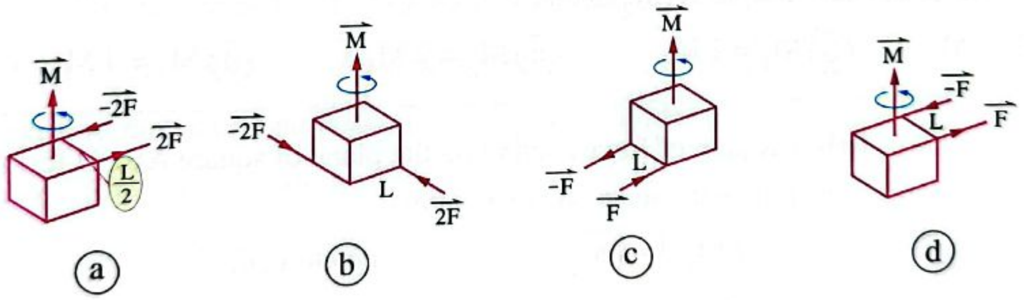
---

104 If a body is in equilibrium under action of four forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$, $\overrightarrow{F_3}$, $\overrightarrow{F_4}$ and $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ form a couple , then ....

(a) $\overrightarrow{F_3} = \overrightarrow{F_4}$ (b) $\overrightarrow{F_3} = -\overrightarrow{F_4}$ (c) $\overrightarrow{F_3} = \overrightarrow{F_2}$ (d) $\overrightarrow{F_4} = -\overrightarrow{F_1}$

---

105 Forces of each of the following figures gives equivalent couples except figure ....



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106 If the forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$, $\overrightarrow{F_3}$ act at the points $(0 , 0)$, $(1 , 0)$, $(0 , 1)$ and equivalent to a couple such that $\overrightarrow{F_1} = 3\,\hat{i} + 4\,\hat{j}$, $\overrightarrow{F_2} = -\hat{i} + \hat{j}$, then the norm of the moment of the couple = ...

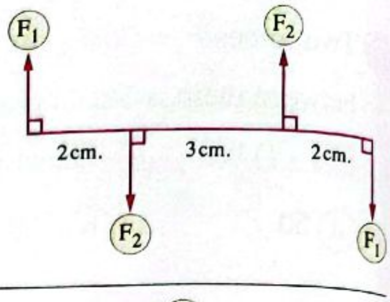
(a) 3 (b) -3 (c) 4 (d) 6

---

107 If A , B , C are three non-collinear points such that there is a set of forces on its plane form a couple and $2\,M_A + 3\,M_B + 5\,M_C = 240$ N.cm. , then $4\,M_A - 2\,M_C =$ .... N.cm.

(a) 24 (b) 48 (c) 96 (d) 192

108 **In the opposite figure :**



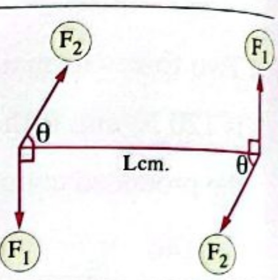
If the system is in equilibrium , then ....

(a) $F_1 > F_2$ (b) $F_1 < F_2$

(c) $F_1 = F_2$ (d) $\frac{F_1}{F_2} = \frac{3}{2}$

---

109 **In the opposite figure :**



If the system is in equilibrium , then .... (where θ is acute angle)

(a) $F_1 > F_2$ (b) $F_1 < F_2$

(c) $F_1 = F_2$ (d) $F_2 = F_1 \sin\theta$

---

110 If the two forces $\overrightarrow{F_1} = a\,\hat{i} + b\,\hat{j}$, $\overrightarrow{F_2} = (13\text{ N.} , \theta°)$ form a couple where $\sin\theta = \frac{5}{13}$, then a + b = ...

(a) 7 or 17 (b) 7 or – 17 (c) – 7 or 17 (d) – 7 or – 17

---

111 The magnitude of moment of a couple is (M_1), if the magnitude of each forces is doubled and the perpendicular distance between them is halved , then the magnitude of moment of the new couple is (M_2) , then ....

(a) $M_1 = M_2$ (b) $M_1 = 2\,M_2$ (c) $M_2 = 2\,M_1$ (d) $M_1 = 4\,M_2$

---

112 *(2nd Session 2021)* If a system of forces acting on the plane of square ABCD form a couple the norm of its moment equals 40 newton.cm.

, then $\|\overrightarrow{M_A}\| + \|\overrightarrow{M_B}\| + 3\,\|\overrightarrow{M_C}\| - \|\overrightarrow{M_D}\| =$ .... newton.cm.

(a) 240 (b) 80 (c) 120 (d) 160

---

113 If $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two forces form a couple where $2 \le F_1 \le 8$, $5 \le F_2 \le 11$ and the perpendicular distance between them is 4 length units. If the magnitude of the couple moment produced by $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ equals M moment units , then ....

(a) $0 \le M \le 12$ (b) $8 \le M \le 32$ (c) $20 \le M \le 32$ (d) $20 \le M \le 44$

---

114 Two couples $\overrightarrow{M_1}$ and $\overrightarrow{M_2}$ act on a body such that $\|\overrightarrow{M_1}\| = 8$, $\|\overrightarrow{M_2}\| = 6$, then the probability that the algebraic measure of their resultant couple acting on the body equals 14 is ....

(a) zero (b) 1 (c) $\frac{1}{3}$ (d) $\frac{1}{4}$

115 If the moment of the force $\overrightarrow{F_1} = 2\,\hat{i} - \hat{j}$ acts about A $(-1 , 4)$ is $11\,\hat{k}$ and the moment of the force $\overrightarrow{F_2} = \hat{j} - 2\,\hat{i}$ about A is $-2\,\hat{k}$, then the sum of the two moments about B $(1 , 1)$ is ....

(a) $-13\,\hat{k}$ (b) $-9\,\hat{k}$ (c) $9\,\hat{k}$ (d) $13\,\hat{k}$

---

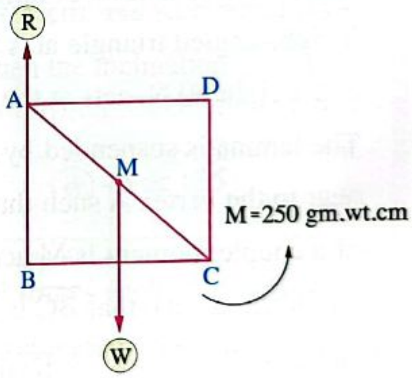
116 $\|\vec{F}\| = 15\sqrt{3}$ N. and $\vec{F} \times (\hat{i} + \hat{j} + \hat{k}) = \overrightarrow{zero}$ the force $\vec{F}$ acts at the point A $(-1 , 0 , 2)$ and the force $-\vec{F}$ acts at the point B $(-1 , 1 , 1)$ if the two forces $\vec{F}$ and $-\vec{F}$ form a couple , then the moment vector of this couple is ....

(a) $-30\,\hat{i} + 15\,\hat{k}$ (b) $-30\,\hat{i} + 15\,\hat{j} + 15\,\hat{k}$

(c) $-30\,\hat{i} + 15\,\hat{j}$ (d) $30\,\hat{i} - 15\,\hat{j} - 15\,\hat{k}$

---

117 ABCD is a uniform square lamina rotates in a vertical plane about a hole at A It has side length 50 cm. It is in equilibrium when the side $\overline{AB}$ coincide with the vertical under effect of a couple its moment is 250 gm.wt. cm. acting perpendicular to the lamina plane , then W = R = ... gm.wt

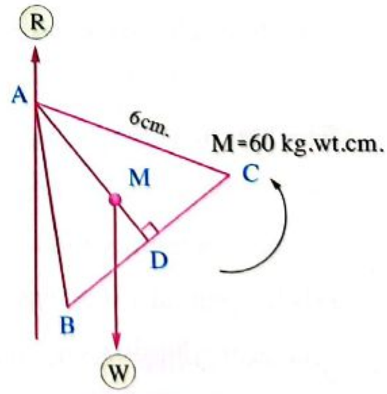


(a) 2 (b) 5 (c) 10 (d) 25

---

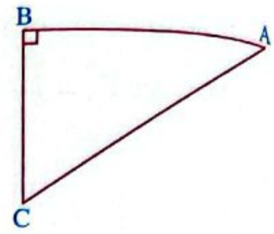
118 **In the opposite figure :**

ABC is a uniform equilateral triangular lamina the length of its side is 6 cm. and rotates about a pin at A in a vertical plane under effect of a couple its moment is 60 kg.wt.cm. acting perpendicular to the lamina plane , if the weight of the lamina W = 20 kg.wt. Then the angle of inclination of $\overline{AM}$ to the vertical = ...



(a) 60° or 120° (b) 30° or 150° (c) 90° (d) 45° or 135°

119 ***(1st Session 2021)* In the opposite figure :**



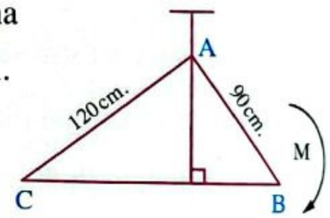
A fine lamina of a uniform thickness and density in the form of a right-angled triangle at B and of weight 30 kg.wt. acts at the point of intersection of its medians.

Where AB = 9 cm. , BC = 6 cm. the lamina is suspended in a pin at a small hole near to the vertex B , a couple in its plane acted on it to make it in equilibrium when $\overline{AB}$ is horizontal , then the algebraic measure of the moment of the couple = ... kg.wt.cm.

(a) 135 (b) – 90 (c) – 135 (d) 90

---

120 **In the opposite figure :**

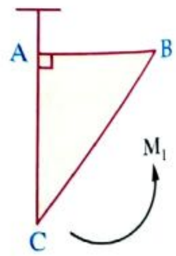


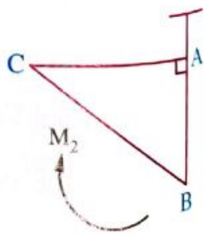
ABC is a fine lamina of uniform density and thickness. The lamina is right-angled triangle at A in which AB = 90 cm. , AC = 120 cm. and weight 50 N. acts at the point of intersection of its medians. The lamina is suspended by a pin passes through a small hole near to the vertex A such that its plane is vertical , the magnitude of a couple moment is M acts on the lamina and makes it in equilibrium such that $\overline{BC}$ is horizontal , then M = ... N.cm.

(a) 450 (b) 600 (c) 700 (d) 750

---

121 **In the opposite figure :**

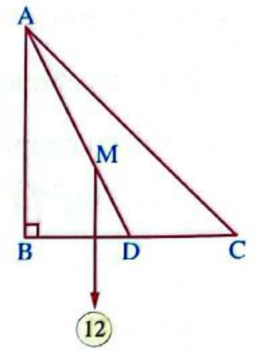




ABC is a fine lamina of uniform density and thickness , the lamina is right-angled triangle at A in which AB = 9 cm. , AC = 12 cm. and its weight (W) acts at the point of intersection of its medians. The lamina is suspended by a pin passing through a small hole near to the vertex A. If a couple , the magnitude of its moment is M_1 acts on the lamina , the lamina rests in equilibrium such that $\overline{AB}$ horizontal , if a couple , the magnitude of its moment is M_2 acts on the lamina , the lamina rests in equilibrium such that $\overline{AC}$, horizontal , then $M_1 : M_2$ = ...

(a) 2 : 3 (b) 3 : 4 (c) 3 : 5 (d) 4 : 5

122 ***(2nd Session 2021)*** **In the opposite figure :**



ABC is a lamina of uniform thickness and density in the form of right-angled triangle at B , BC = 30 cm. and its weight 12 newton , it can easily rotate about a small pin fixed near from the vertex A. If the lamina is in equilibrium under the action of a couple in its plane when $\overline{AB}$ is vertical , then the norm of the moment of the couple = ... newton.cm.

(a) 30 (b) 60 (c) 120 (d) 45

---

123 ABCD is a fine lamina in the form of a rectangle in which AB = 18 cm. , BC = 24 cm. and of weight 20 newton acting at the intersection of its diagonals. The lamina is suspended by a thin horizontal pin passing through a small hole near the vertex D so that its plane is vertical. If a couple , the magnitude of its moment is 150 newton.cm. and its direction is perpendicular to the plane of the lamina acts on the lamina , then the inclination of $\overline{DB}$ to the vertical in the position of equilibrium = ...°

(a) 60 or 120 (b) 30 or 150 (c) 90 (d) 45 or 135

---

124 $\overline{AB}$ is a rod of negligible weight and length 1.5 m. two equal forces each of magnitude 200 newton act at its points of trisection in two opposite directions perpendicular to the rod. If these two forces are replaced by two other forces each of magnitude 120 newton acting at the ends of the rod such that they form a couple equivalent to the first couple. Then the inclination of the lines of action of these two forces to the rod is ....

(a) 45° (b) 36° 45' (c) 33° 45' (d) 30° 15'

---

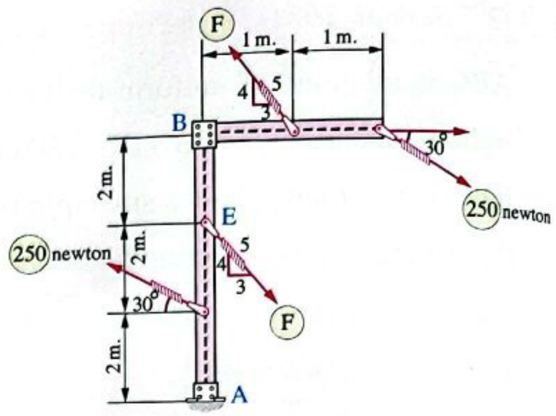
125 $\overline{AB}$ is a rod of length 60 cm. and of weight 18 newton acting at its midpoint , can rotate easily in a vertical plane about a horizontal pin passing through a hole in the rod at the point C , 15 cm. distant from A. If the rod rests with its end B on a smooth horizontal table , and the end A is pulled with a rope horizontally until the reaction of the table becomes equal to the weight of the rod. Then the tension in the rope given that the rod is in equilibrium in a position in which it is inclined at an angle of measure 60° to the horizontal = ... N.

(a) $9\sqrt{3}$ (b) $10\sqrt{3}$ (c) $11\sqrt{3}$ (d) $12\sqrt{3}$

126 **In the opposite figure :**

If the algebraic measure of the moment of the resultant couple equals $\left(150 - 500\sqrt{3}\right)$ newton.m.

Then F = ... N.



ⓐ 100 ⓑ 145

ⓒ 175 ⓓ 200

---

127 ABCDE is a regular pentagon of side length 15 cm. Forces each of magnitude 10 kg.wt. act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DE}$ and $\overrightarrow{EA}$ respectively , then the system is equivalent to a couple and the magnitude of its moment. = ... kg.wt.cm.

ⓐ 200.1 ⓑ 314.16 ⓒ 411.56 ⓓ 516.14

---

128 ABCD is a quadrilateral in which AB = AD = 20 cm. , BC = CD = $10\sqrt{7}$ cm. , m (∠ A) = 120° , forces represented by the directed line segments $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$ and $\overrightarrow{DA}$ act on. If the system tends to a couple the magnitude of its moment is $180\sqrt{3}$ newton. cm. in the direction of ABCD , then the magnitude of the forces acting on the sides of the figure equals .... N.

ⓐ 6 , 3 , 3 , 6 ⓑ 6 , $3\sqrt{7}$, $3\sqrt{7}$, 6

ⓒ 3 , $6\sqrt{7}$, $6\sqrt{7}$, 3 ⓓ 3 , $7\sqrt{6}$, $7\sqrt{6}$, 3

Sixth Questions on centre of gravity

Choose the correct answer from those given :

1. The centre of gravity of a system made up of two masses 6 , 9 kg the distance between them is 10 m is distant .... m from the first mass.

(a) 3 (b) 4 (c) 5 (d) 6

2. The centre of gravity of a system made up of two masses 7 kg and 11 kg. and the distance between them is 90 cm. is distant .... cm. from the first mass.

(a) 50 (b) 55 (c) 35 (d) 45

3. 5 kg. mass is fixed at the point (2 , – 1) and 7 kg. mass is fixed at the point (1 , 2) , then the centre of gravity of the two masses acts at the point ....

(a) (17 , 9) (b) $\left(\frac{17}{12}, \frac{3}{4}\right)$ (c) (19 , 13) (d) $\left(\frac{19}{12}, \frac{1}{4}\right)$

4. The centre of gravity of the following system , $m_1 = 1$ at (2 , 3) , $m_2 = 2$ at (– 2 , 1) , $m_3 = 3$ at (0 , 1) is ....

(a) $\left(\frac{-1}{3}, \frac{4}{3}\right)$ (b) $\left(\frac{7}{6}, \frac{4}{3}\right)$ (c) $\left(\frac{-1}{3}, \frac{2}{3}\right)$ (d) (0 , 1)

5. The centre of gravity of two physical particles separated by a constant distance lies on the line segment connecting them and divides its length in .... ratios to the ratios between the two masses.

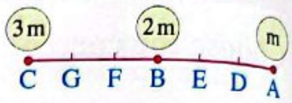
(a) direct (b) inverse (c) random (d) constant

6. **In the opposite figure :**

$\overline{AB}$ is a light rod. m_1 and m_2 are two masses fixed at A and B the centre of gravity of the system acts at C where $C \in \overline{AB}$, then $\frac{AC}{AB} =$ ....

(a) $\frac{m_1}{m_1 + m_2}$ (b) $\frac{m_2}{m_1 + m_2}$ (c) $\frac{m_1 m_2}{m_1 + m_2}$ (d) $\frac{m_1 + m_2}{m_1 m_2}$

7 **In the opposite figure :**



Three masses m , 2 m , 3 m fixed at A , B , C respectively , then the centre of gravity of the system lies at the point ....

(a) E (b) B (c) F (d) G

---

8 A uniform rod of length 6 m and weight 11 kg.wt. masses of weight 2 , 3 , 4 , 5 kg.wt are fixed at distances 1 , 2 , 3 , 4 m from one of its ends then the centre of gravity of the system acts at a point far from this end a distance of ....

(a) $\frac{53}{25}$ (b) $\frac{63}{25}$ (c) $\frac{73}{25}$ (d) $\frac{83}{25}$

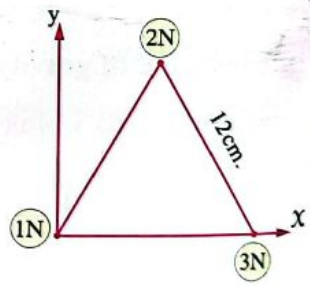
---

9 If three equal masses are fixed at the vertices of triangle ABC where A (2 , 1) , B (3 , 4) , C (4 , 1) , then the centre of gravity of the system is ....

(a) (2 , 3) (b) (3 , 2) (c) (6 , 9) (d) (9 , 6)

---

10 The opposite figure represents an equilateral triangle , its side length is 12 cm. Masses of weight 1 , 2 , 3 N. are placed at its vertices then the coordinates of the centre of gravity of the system is ....



(a) $(4 , \sqrt{3})$ (b) $(\sqrt{3} , 4)$

(c) $(8 , 2\sqrt{3})$ (d) $(2\sqrt{3} , 4)$

---

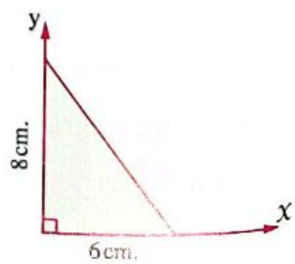
11 Three equal masses are fixed at the vertices of an isosceles right triangle at angle A , BC = 8 cm. , M is the centre of gravity of the system , then AM = ... cm.

(a) 6 (b) $\frac{8}{3}$ (c) 4 (d) 8

---

12 **In the opposite figure :**

The centre of gravity of the uniform shaded lamina is ....

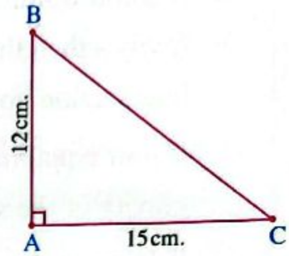


(a) (3 , 4) (b) (4 , 3)

(c) $\left(2 , \frac{8}{3}\right)$ (d) $\left(\frac{8}{3} , 2\right)$

13 The centre of gravity of the following system with respect to point A is ....

Mass	20 gm.	40 gm.	30 gm.
Position	at A	at B	at C

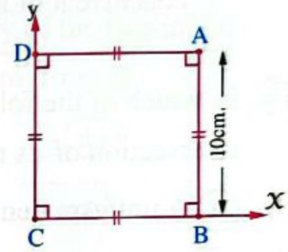


(a) $(5, 4)$ (b) $\left(5, \frac{16}{3}\right)$

(c) $\left(\frac{7}{3}, \frac{10}{3}\right)$ (d) $\left(\frac{7}{2}, 6\right)$

14 The centre of gravity of the following system with respect to C is ....

Mass	20 gm.	30 gm.	10 gm.	40 gm.
Position	at A	at B	at C	at D



(a) $(4, 7)$ (b) $(7, 4)$ (c) $(5, 6)$ (d) $(6, 5)$

15 The centre of gravity of a uniform thin lamina in the form of a right angled triangle lies at the point of intersection of ....

(a) sides of right angle. (b) angles bisectors. (c) heights. (d) medians.

16 The centre of gravity of a uniform fine lamina in the form of an equilateral triangle of side length 12 cm. lies at a distance .... from one of the vertices of the triangle.

(a) $2\sqrt{3}$ cm. (b) $4\sqrt{3}$ cm. (c) 6 cm. (d) $6\sqrt{3}$ cm.

17 Masses 10 , 20 , 10 , 30 , 10 and 40 are attached at vertices A , B , C , D , E and F respectively of a uniform hexagon of side length 60 cm. Then the distance between the centre of gravity of this system and the centre of the hexagon.

(a) 3 (b) 5 (c) $3\sqrt{5}$ (d) $5\sqrt{3}$

18 **Which of the following statement is correct :**

(a) If a non-uniform lamina bounded by a triangle is suspended from one of its vertices freely , then the vertical line passing through the suspension point passes through the intersection point of the medians of the triangle.

(b) If four equal masses are placed at vertices of an isosceles trapezium , then the centre of gravity of the system acts at the intersection point of its diagonals.

(c) If four equal masses are placed at the vertices of a parallelogram , then the centre of gravity of the system acts at the intersection point of the diagonals of the parallelogram.

(d) The centre of gravity of regular thin and density wire in triangular form lies at point of concurrent of its medians.

---

19 In which of the following shapes the centre of gravity is not the same as the point of intersection of its medians ?

(a) A uniform density lamina in form of an equilateral triangle.

(b) A uniform density lamina in form of a scalene triangle.

(c) A uniform density thin wire in form of an equilateral triangle.

(d) A uniform density thin wire in form of a scalene triangle.

---

20 Two bodies of masses 10 , m gm. act at two points A , B respectively where AB = 50 cm. , the centre of gravity of the two bodies acts at point $C \in \overline{AB}$ where AC = 20 cm. , then m = ... gm.

(a) 20 (b) $\frac{20}{3}$ (c) 40 (d) $\frac{40}{3}$

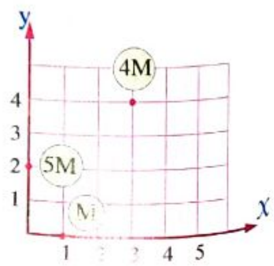
---

21 Thin wire of uniform density is bent to form right-angled triangle at ∠ B , in which AB = 3 cm. , BC = 4 cm. , then the distances of the gravity centre of the wire from $\overline{BA}$, $\overline{BC}$ are ....

(a) (1.5 , 1) (b) (2 , 1.5) (c) $\left(\frac{8}{7}, \frac{9}{14}\right)$ (d) $\left(\frac{12}{7}, \frac{11}{14}\right)$

---

22 The opposite figure represents three masses m , 4 m , 5 m , then the gravity centre of the system lies at the point ....



(a) $\left(\frac{13}{10}, \frac{13}{5}\right)$ (b) $\left(\frac{9}{5}, \frac{27}{10}\right)$

(c) $\left(\frac{17}{10}, \frac{27}{10}\right)$ (d) $\left(\frac{13}{5}, \frac{13}{10}\right)$

23. Three masses 3kg. , 2kg. , m kg are placed at the points (6 , 4) , (3.5 , 5) , (1 , 2) respectively. The centre of gravity of the system at the point (3 , y) , then y = ...

(a) 3 (b) 3.2 (c) 3.4 (d) – 3.2

24. If a mass of 1 kg. is placed at the position A (2 , 1) , 2 kg is placed at B (3 , 2) , 3 kg is placed at C (– 4 , 5) and 4 kg. at D (x , y) the centre of the gravity of the system is the origin , then (x , y) = ...

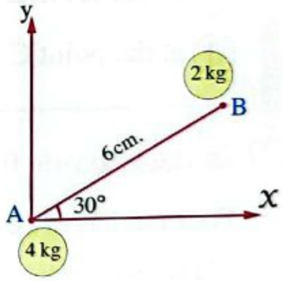
(a) (1 , 5) (b) (2 , 3) (c) (1 , – 5) (d) (5 , – 1)

25. If m_1 , m_2 are two masses situated at A and B respectively where AB = 12 cm. and their centre of gravity at a distance 4 cm. from B , then the centre of gravity of the two masses 2 m_1 , m_2 which situated at A and B also lies at a distance .... cm. from B.

(a) 2 (b) 14 (c) 6 (d) 8

26. **In the opposite figure :**

The centre of gravity of the system = ...



(a) (4 , 2)
(b) (2 , 4)
(c) ($\sqrt{3}$, 1)
(d) (1 , $\sqrt{3}$)

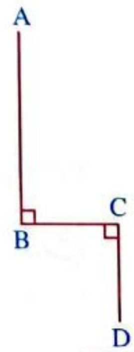
27. **In the opposite figure :**

A metal uniform beam of length 1 m. and weight 1 kg.wt. An iron uniform ball of weight $\frac{1}{2}$ kg.wt. and diameter length 20 cm. is fixed at the end A , then the centre of gravity of the system is at a distance .... cm. from B.

(a) 50 (b) 60 (c) 15 (d) 70

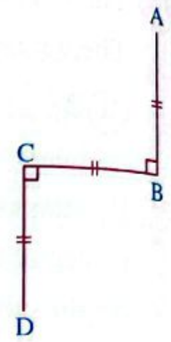
28. **In the opposite figure :**

ABCD is a wire of length 32 cm. in which AB = 2 BC = 2 CD = 16 cm. , then the distance between the center of gravity of the wire and both $\overleftrightarrow{BC}$ and $\overleftrightarrow{BA}$ respectively is ....



(a) (3 , 3) (b) (4 , 4)
(c) (3 , 5) (d) (4 , 8)

29 The opposite figure represents a uniform rod. It's bent into three equal parts , then the centre of rod lies at the ....



(a) midpoint of $\overline{AB}$

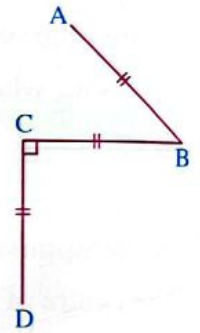
(b) midpoint of $\overline{BC}$

(c) midpoint of $\overline{CD}$

(d) point C

---

30 A uniform rod has been bent into 3 equal parts then the centre of mass of the rod lies ....



(a) at the midpoint of $\overline{BC}$

(b) inside Δ BCD

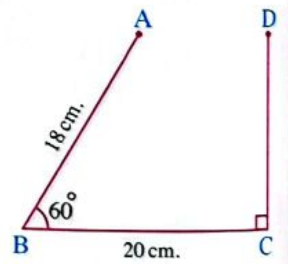
(c) inside Δ ABC

(d) at the point C

---

31 **In the opposite figure :**

Four masses m , 2 m , 3 m , 4 m are fixed at the points A , B , C , D respectively on the broken line ABCD , consider $\overrightarrow{BC}$ and its perpendicular from B are the positive direction of the coordinate axes then the centre of gravity of the system = ...



(a) $(4.5 , \sqrt{3})$

(b) $(4.5 , 14\sqrt{3})$

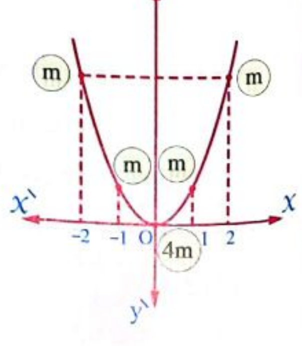
(c) $(14.9 , 4.5\sqrt{3})$

(d) $(14.9 , 4.5)$

---

32 **In the opposite figure :**

Five masses m , m , 4 m , m , m are fixed on the curve of the function $f : f(x) = 2x^2$ at the points that have x-coordinates 2 , 1 , 0 , –1 , –2 respectively as shown in the figure then the centre of gravity of the system = ...



(a) (0 , 2.5)

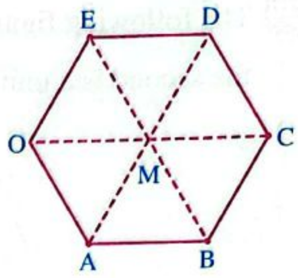
(b) (0 , 3)

(c) (0 , 5)

(d) (0 , 5.5)

33 **In the opposite figure :**

Four equal masses are fixed at the vertices A , B , C , E of a regular hexagon its centre is M. If N is the centre of gravity of the system , then NB : NE = ...



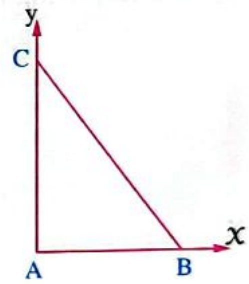
(a) 1 : 3 (b) 1 : 4 (c) 3 : 5 (d) 3 : 8

34 $\overline{AB}$ is a line segment of length 150 cm. Two bodies of masses 1 kg. , 3 kg. are placed at a distance 15 cm. , 50 cm. from the end A and end B respectively , then the distance at which a mass 2 kg. should be placed from the end A such that the centre of gravity of the system lies at the midpoint of $\overline{AB}$ = ... cm.

(a) 40 (b) 50 (c) 67.5 (d) 75

35 **In the opposite figure :**

ABC is a triangle in which AB = 9 cm. , AC = 12 cm. Masses 3 gm. , k gm. , m gm. are placed at the points A , B , C respectively. If the center of gravity of the system is (3 , 4) , then 2 m + 3 k = ...



(a) 10 (b) 12 (c) 15 (d) 23

36 If a uniform fine lamina in the form of an equilateral triangle ABC is suspended by a string from a point on one of its edges (as $\overline{AC}$) dividing it in ratio 1 : 2 (from C) , then the angle of inclination of this edge to the vertical is equal to ....

(a) 22.5° (b) 30° (c) 45° (d) 60°

37 ABC , ABD are two laminas each in the form of an isosceles triangle of common base $\overline{AB}$ and on different sides of it. , their heights corresponding to this base are 12 cm. , 6 cm. respectively, then the centre of gravity of the system distant from AB = ... cm.

(a) $\frac{1}{2}$ (b) 1 (c) 1.5 (d) 2

38 A uniform lamina in the form of an equilateral triangle is freely suspended from one of its vertices then the side opposite to this vertex makes with the horizontal .... angle.

(a) a zero (b) a right. (c) acute. (d) an obtuse.

39 The following figures represent three congruent triangles , the first is a uniform lamina , the second is a uniform rod and the third consists of three equal masses

Figure (1) Figure (2) Figure (3)

Which of the previous figures have same centre of gravity ?

(a) figure (1) and figure (2)
(b) figure (2) and figure (3)
(c) figure (1) and figure (3)
(d) figure (1) , figure (2) and figure (3)

---

40 The following figures represent three congruent triangles :

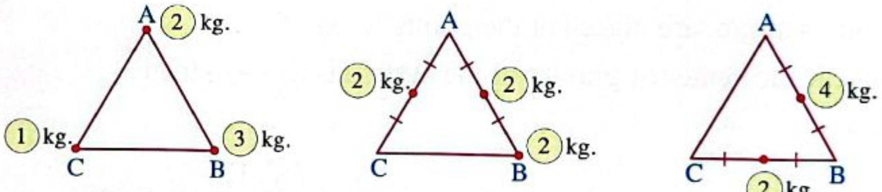


Figure (1) Figure (2) Figure (3)

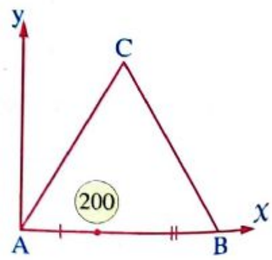
Which of the previous figures have same centre of gravity ?

(a) figures (1) , (2) only
(b) figures (1) , (3) only
(c) figures (2) , (3) only
(d) figures (1) , (2) , (3)

---

41 **In the opposite figure :**

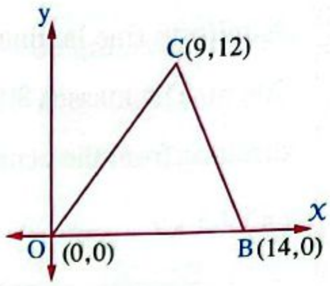
A fine lamina of mass 600 gm. in the form of an equilateral triangle of side length 36 cm. a mass of 200 gm. is fixed on the lamina at trisection point of $\overline{AB}$, then the centre of gravity of the system with respect to the orthogonal axes $\overleftrightarrow{Ax}$ and $\overleftrightarrow{Ay}$ is ....



(a) $(16.5 , 4.5\sqrt{3})$
(b) $(6 , 4.5\sqrt{2})$
(c) $(18 , 4.5\sqrt{2})$
(d) $(18 , 6\sqrt{3})$

42 *(2nd Session 2021)* **In the opposite figure :**

A thin wire of uniform thickness and density in the form of a triangle OBC , where B (14 , 0) and C (9 , 12) , then the co-ordinates of the center of gravity of the wire is ....

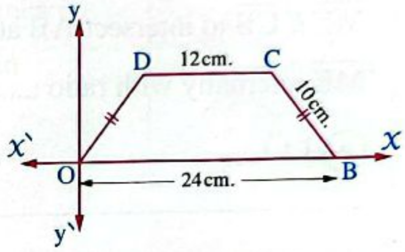


(a) (7.5 , 4) (b) (4 , 7) (c) (4.5 , 7) (d) (7 , 4.5)

---

43 *(1st Session 2021)* **In the opposite figure :**

A wire of a uniform thickness and density in the shape of a trapezium OBCD in which $\overline{CD} \parallel \overline{BO}$, OD = BC = 10 cm. , CD = 12 cm. , OB = 24 cm. , then the center of gravity of the wire is ....

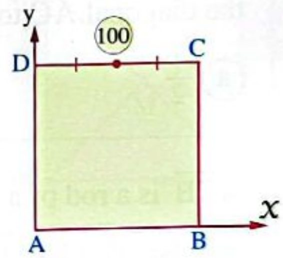


(a) $\left(12 , \frac{22}{7}\right)$ (b) $\left(\frac{22}{7} , 12\right)$ (c) $\left(10 , \frac{22}{7}\right)$ (d) $\left(\frac{22}{7} , 10\right)$

---

44 **In the opposite figure :**

A lamina of uniform thickness and density of mass 400 gm. in form of a square ABCD. Its side length 16 cm. A 100 gm. mass has been attached to the lamina at the midpoint of $\overline{CD}$, then the centre of gravity of the system with respect to the axes $\overrightarrow{Ax}$, $\overrightarrow{Ay}$ is ....



(a) (9.6 , 9.6) (b) (8 , 9.6) (c) (8 , 16) (d) (8 , 12)

---

45 ABC is a lamina in the form of an equilateral triangle of mass 3 kg. and M is its centre of gravity, masses of magnitudes 2 , 2 and 11 are placed at the vertices A , B and C respectively if D is the midpoint of $\overline{AB}$, then the centre of gravity of the system lies at ....

(a) the midpoint of $\overline{CD}$

(b) the midpoint of $\overline{MC}$

(c) the point of division of $\overline{CD}$ with ratio 1 : 5

(d) the point of division of $\overline{CD}$ with ratio 5 : 1

46 A uniform fine lamina of mass 200 gm. in the form of square ABCD which its length 20 cm. The masses 80, 30, 50, 40 gm. are fixed at A, B, C, D respectively then the distance from the centre of gravity of the system and each of $\overline{AB}$ and $\overline{AD}$ = ... cm.

(a) 9.5, 9 (b) 9.5, 8 (c) 8, 9 (d) 9, 8.5

47 ABC is a uniform light lamina in the form of a triangle its centre at (M), the weights 6, 8, 4 gm.wt. are fixed at the vertices A, B, C respectively. If $\overline{ME}$ is drawn such that $\overline{ME} \parallel \overline{CB}$ to intersect $\overline{AB}$ at E. If N is the centre of gravity of these masses then N divides $\overrightarrow{ME}$ internally with ratio ....

(a) 1 : 1 (b) 1 : 2 (c) 1 : 3 (d) 2 : 3

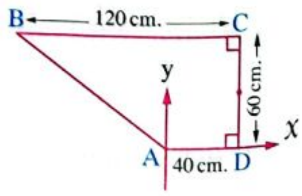
48 A uniform squared lamina of weight (W) is suspended freely from the vertex A and a weight of $\left(\frac{1}{4} W\right)$ is fixed at vertex B then the tangent of the angle of inclination of the diagonal $\overline{AC}$ to the vertical in the equilibrium position is equal to ....

(a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{1}{4}$ (d) $\frac{1}{5}$

49 $\overline{ACB}$ is a rod of a uniform thickness where AC = CB. If its half $\overline{AC}$ is made of a material and the other half $\overline{CB}$ is made of another material and the centre of gravity of the rod is at a distance $\frac{2}{3}$ of its length from A, then the ratio between the weights of the two halves of the rod = ...

(a) $\frac{2}{3}$ (b) $\frac{3}{4}$ (c) $\frac{1}{5}$ (d) $\frac{3}{5}$

50 The opposite figure represents a thin steel frame in the form of a trapezium ABCD in which AD = 40 cm., CD = 60 cm., BC = 120 cm., if you know that the part $\overline{AD}$ is made of a steel of density equals twice the density of the steel which made the remaining parts and m (∠ C) = m (∠ D) = 90°, then the centre of gravity of the frame = ...



(a) $\left(\frac{-20}{3}, 30\right)$ (b) $\left(\frac{-20}{3}, \frac{97}{3}\right)$ (c) $\left(\frac{20}{3}, \frac{100}{3}\right)$ (d) $\left(\frac{-20}{3}, \frac{100}{3}\right)$

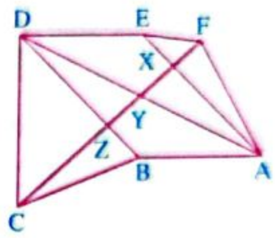
51 A wire of uniform thickness and density, length 120 cm. and mass 600 gm. is bent in the form a right-angled triangle at B where AB = 30 cm. , if a mass of a magnitude m gm. is attached at vertex A, then the wire is freely suspended from vertex B to be in equilibrium when $\overline{AC}$ is horizontal, then m = ... gm.

(a) 100 (b) 150 (c) 200 (d) 250

---

52 **In the opposite figure :**

ABCDEF is a lamina. When it is hanged from B , $\overline{BD}$ becomes vertical when it is hanged from C , $\overline{CF}$ becomes vertical then the centre of gravity of the lamina is the point ....

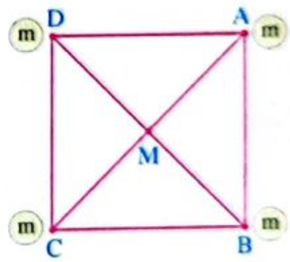


(a) X (b) Y

(c) Z (d) the midpoint of $\overline{AY}$

---

53 The opposite figure represents a system of 4 equal masses placed at the vertices of a square , if the mass at B has been moved in $\overrightarrow{BM}$ direction then the centre of gravity of the system ....



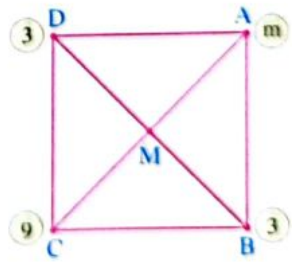
(a) remains fixed at M (b) moves in $\overrightarrow{MB}$ direction.

(c) moves in $\overrightarrow{MD}$ direction. (d) moves in $\overrightarrow{MA}$ direction.

---

54 **In the opposite figure :**

ABCD is a square , four masses m , 3 , 9 , 3 has been fixed at its vertices , then the value of m which makes the centre of gravity of the system lies at the midpoint of $\overline{MC}$ equals ....

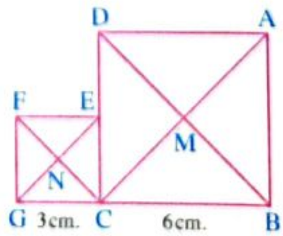


(a) 1 (b) 2 (c) 3 (d) 9

---

55 **In the opposite figure :**

The centre of gravity of the lamina formed from two squares divides $\overline{MN}$ with a ratio .... from M.

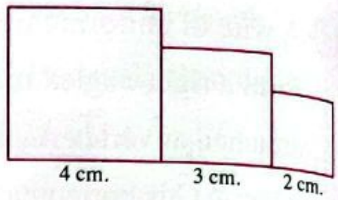


(a) 1 : 2 (b) 2 : 1

(c) 1 : 4 (d) 4 : 1

56 **In the opposite figure :**

A lamina in form of 3 squares their sides lengths 2 cm. , 3 cm. and 4 cm. , then the centre of gravity of the lamina lies ....



(a) inside the small square.

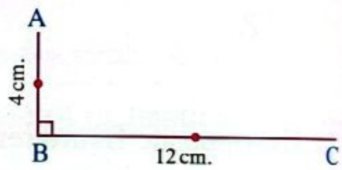
(b) inside the middle square.

(c) inside the big square.

(d) on the line between the middle square and the greatest one.

---

57 The opposite figure represents a wire of a uniform density and thickness such that : AB = 4 cm. , BC = 12 cm. , m (∠ B) = 90° . If the wire is suspended freely from B , then the tangent of the angle of inclination of $\overleftrightarrow{BC}$ to the vertical in the equilibrium position is ....

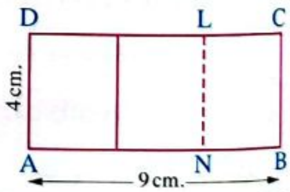


(a) $\frac{1}{9}$ (b) $\frac{1}{3}$

(c) $\frac{1}{2}$ (d) 3

---

58 The opposite figure shows a fine uniform lamina in the form of a rectangle of dimensions 9 cm. , 4 cm. The lamina is divided into three congruent rectangles and the lamina is bent about $\overleftrightarrow{LN}$ such that the surface of region BCLN touched the surface of the remaining lamina, then the distance of the centre of gravity from $\overleftrightarrow{AD}$ is .... cm.

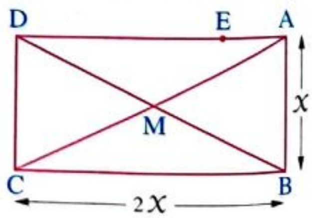


(a) 3 (b) $3\frac{1}{2}$

(c) 4 (d) 4.2

---

59 **In the opposite figure :** A rectangular lamina , its length twice its width. It is freely suspended from point E ∈ $\overline{AD}$ and hangs in equilibrium when $\overline{BD}$ becomes horizontal , then AE = ...



(a) $\frac{5}{4}x$ (b) $\frac{1}{4}x$ (c) $\frac{3}{8}x$ (d) $\frac{3}{4}x$

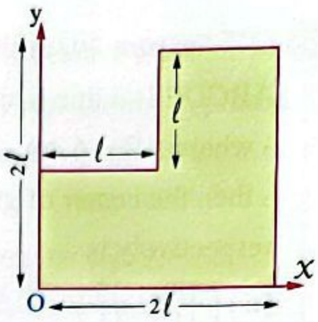
---

60 A uniform fine lamina is bounded by a parallelogram ABCD in which AB = 20 cm. , AD = 10 cm. , m (∠BAD) = 60°. If the lamina is suspended freely from a point E ∈ $\overline{DC}$ and $\overline{AB}$ is horizontal then the length of $\overline{ED}$ = ... cm.

(a) 7.5 (b) 10 (c) 12.5 (d) 15

61 **In the opposite figure :**

A fine lamina of uniform thickness and density , then its centre of gravity ....



(a) $\left(\frac{5}{6}\ell , \frac{5}{6}\ell\right)$ (b) (ℓ , ℓ)

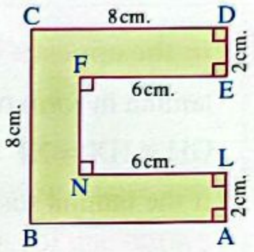
(c) $\left(\frac{7}{6}\ell , \frac{5}{6}\ell\right)$ (d) $\left(\frac{3}{2}\ell , \ell\right)$

---

62 ***(1st Session 2021)*** **In the opposite figure :**

A lamina of uniform thickness and density , AB = BC = CD = 8 cm. , LN = EF = 6 cm. , DE = AL = 2 cm.

, then the distances between the centre of gravity of the lamina and each of $\overrightarrow{BC}$, $\overrightarrow{BA}$ is ....



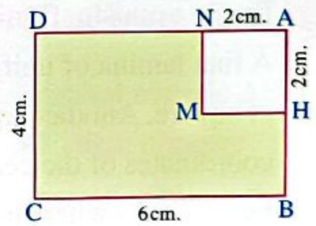
(a) 4.3 cm. , 3 cm. (b) 4 cm. , 3 cm.

(c) 3.4 cm. , 4 cm. (d) 3 cm. , 4 cm.

---

63 ***(1st Session 2021)*** **In the opposite figure :**

A fine lamina of a uniform thickness and density in the form of a rectangle ABCD whose dimensions are 6 cm. , 4 cm. If the square AHMN of side length 2 cm. is cut off as shown in the figure , then the distances between the center of gravity of the remaining part and each of $\overrightarrow{CD}$, $\overrightarrow{CB}$ respectively is .... cm.



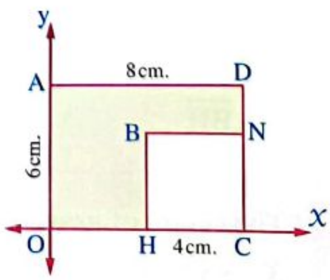
(a) 2.6 cm. , 2.4 cm. (b) 2.6 cm. , 1.8 cm.

(c) 1.8 cm. , 2.6 cm. (d) 2.4 cm. , 2.6 cm.

---

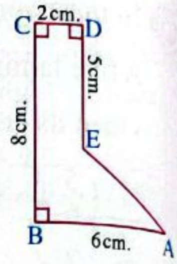
64 ***(2nd Session 2021)*** **In the opposite figure :**

AOCD is a fine lamina of a uniform thickness and density in the form of a rectangle in which AO = 6 cm. , OC = 8 cm. If the square CHBN whose side length 4 cm. is cut off as shown in the figure , then the center of gravity of the remaining part is ....



(a) (3.5 , 3) (b) (3 , 3) (c) (3 , 4) (d) (3 , 3.5)

65 ***(2nd Session 2021)* the opposite figure :**



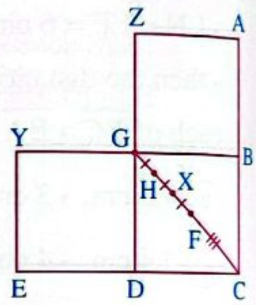
ABCDE is a fine lamina of a uniform thickness and density , where AB = 6 cm. , BC = 8 cm. , CD = 2 cm. and DE = 5 cm. , then the center of gravity of the lamina with respect to $\overrightarrow{BC}$, $\overrightarrow{BA}$ respectively is ....

(a) $\left(\frac{18}{11}, \frac{35}{11}\right)$ (b) $\left(\frac{73}{22}, \frac{20}{11}\right)$

(c) $\left(\frac{48}{11}, \frac{35}{11}\right)$ (d) $\left(\frac{20}{11}, \frac{73}{22}\right)$

---

66 **In the opposite figure :**



lamina in form of three identical squares.

GH = HX = XF = $\frac{1}{3}$ FC.

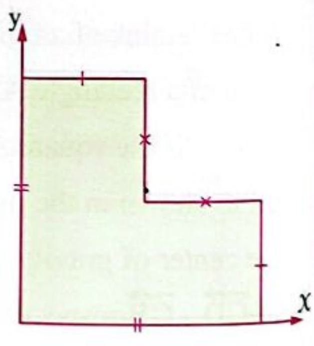
If the lamina suspended from A , then .... becomes vertical.

(a) $\overline{AH}$ (b) $\overline{AF}$

(c) $\overline{AG}$ (d) $\overline{AX}$

---

67 **In the opposite figure :**



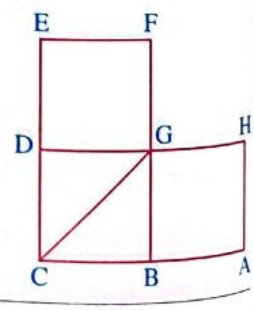
A fine lamina of uniform thickness and density in form of square. Another square has been removed then the coordinates of the centre of gravity of remaining part could be .... where a $\in \mathbb{R}^+$

(a) $\left(a, \frac{a}{3}\right)$ (b) $\left(\frac{a}{3}, a\right)$

(c) (a , a) (d) nothing of the previous.

---

68 The opposite figure represents a lamina in form of three identical squares. If it is suspended from C , then the vertical line is ....



(a) $\overline{BG}$ (b) $\overline{DG}$

(c) $\overline{BH}$ (d) $\overline{BE}$

---

69 The centre of gravity of a fine uniform circular lamina determined by the equation $x^2 + y^2 - 4x + 6y - 3 = 0$ lies at the point ....

(a) (– 4 , 6) (b) (4 , – 6) (c) (2 , 3) (d) (2 , – 3)

70 A wire of a uniform density and thickness in form of a circle its circumference 50π cm. An equilateral triangle ABC made from a uniform density and thickness lamina is placed inside the circle such that its vertices lie on the circle , if the side length of the triangle is L cm. , then the centre of gravity of the system is at a distance .... cm. from A.

(a) L (b) $\frac{L}{2} + 25$ (c) $\frac{25-3L}{3}$ (d) 25

---

71 A uniform density wire in a circular shape whose equation $x^2 + y^2 = 36$, two masses each of the same weight as the wire are fixed at the two points (6 , 0) , (0 , 6) , then the centre of the system is ....

(a) (3 , 3) (b) (2 , 2) (c) (0 , 0) (d) (6 , 6)

---

72 A fine lamina of uniform thickness and density in the form of a circular disc whose centre is the origin point and radius length 24 cm. , two circular discs the centre of one of them is (– 2 , – 12) and radius length is 4 cm. where the centre of the other disc is (6 , 10) and the radius length is 12 cm. are cut off. Then the centre of gravity of the remaining part of the disc = ...

(a) (2 , 3) (b) (– 2 , – 3) (c) (– 3 , – 2) (d) (– 4 , – 6)

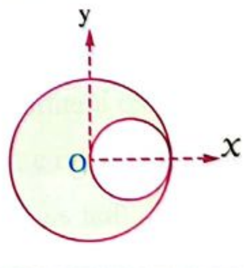
---

73 A metalic lamina of uniform thickness and density in the form of equilateral triangle ABC of side length $8\sqrt{3}$ cm. A circular disc of radius length 4 cm. is cut off , then distance between centre of gravity of remaining part and the vertex A equals .... cm.

(a) 4 (b) $4\sqrt{3}$ (c) 8 (d) 6

---

74 The opposite figure represents a disk with a hole , if the radius of the hole equals r , then the centre of the holed disc is ....

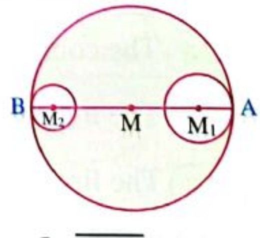


(a) (– r , 0) (b) $\left(\frac{-r}{2}, 0\right)$

(c) $\left(\frac{-r}{3}, 0\right)$ (d) $\left(\frac{-r}{4}, 0\right)$

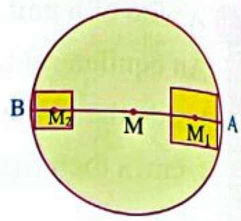
---

75 The opposite figure represents a circular disc whose centre is M , two circular discs are removed of it , their centres are M_1 , M_2 and their radii 3 cm. , 2 cm. respectively , then the centre of gravity of the remaining part lies on ....



(a) $\overline{MM_1}$ (b) $\overline{MM_2}$ (c) $\overline{AM_1}$ (d) $\overline{BM_2}$

76 The opposite figure represents a circular disc with centre M. Two squares their geometrical centres at M_1 and M_2 and their diagonals length are 3 cm. , 2 cm. respectively are attached to the disc , then the centre of gravity of the system lies on ....



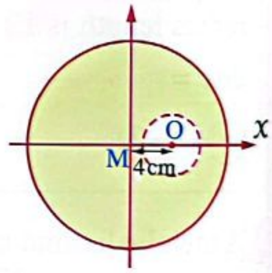
(a) $\overline{MM_1}$ (b) $\overline{MM_2}$ (c) $\overline{AM_1}$ (d) $\overline{BM_2}$

77 The radius length of a uniform circular disc = 10 cm and its centre is (O). Two smaller discs are removed from it , the radius of one is 5 cm. and the radius of the other is 2.5 cm. If the removed discs touching the original disc such that their centres lie on the same straight line then the centre of gravity of the remaining part is at a distance .... cm. from the centre (O)

(a) $\frac{22}{25}$ (b) $\frac{5}{2}$ (c) $\frac{25}{22}$ (d) $\frac{2}{5}$

78 **In the opposite figure :**

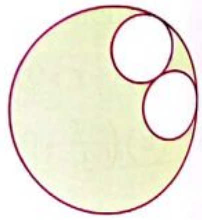
A uniform circular laminan of area 200 cm^2 , a circular portion of area 40 cm^2 is removed from it. If the distance between the centre of the removed portion from the centre of the circular lamina is 4 cm. , then the centre of gravity of the remaining part is at a distance ....



(a) 1 cm. in $\overrightarrow{OX}$ direction.
(b) 1 cm. in $\overrightarrow{OM}$ direction.
(c) 4.5 cm. in $\overrightarrow{OM}$ direction.
(d) 1.5 cm. in $\overrightarrow{OM}$ direction.

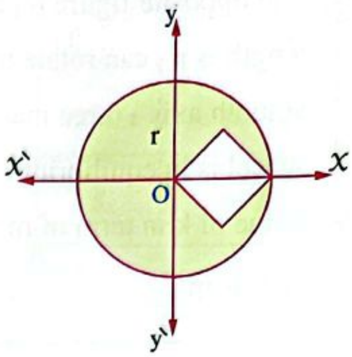
79 **In the opposite figure :**

If two identical circular discs are removed from a bigger one made from a fine lamina of uniform thickness and density such that each one is touching the others as shown in the figure , then the centre of the remaining part lies on ....



(a) The common tangent between the greatest circle and one of the smaller circles.
(b) The inner common tangent between the smaller circles.
(c) The line of centres of the two smaller circles.
(d) The line of centres of the greatest circle and one of the smaller circles.

80 The opposite figure represents a circular lamina of radius length r. A square of diagonal length equals r as shown in the figure has been removed , then the centre of gravity of the remaining part is at a distance .... from the centre of the circle.

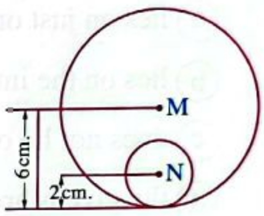


(a) $\frac{r}{\pi - 2}$ (b) $\frac{r}{2\pi - 2}$

(c) $\frac{r}{4\pi - 2}$ (d) $\frac{r}{4\pi + 2}$

---

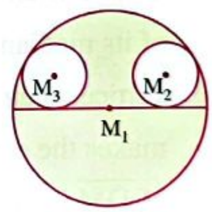
81 The opposite figure represents a uniform circular lamina of radius length 6 cm. and its centre (M) , a circular disc of radius length 2 cm. and its centre (N) is removed , then the centre of gravity of the remaining part is at a distance .... cm. from M



(a) 0.4 (b) 0.5 (c) 1 (d) 2

---

82 A fine uniform lamina has centre M_1 , two congruent circles are removed from it as shown in the figure , then the centre of gravity of the remaining part lies ....



(a) at M_1

(b) at the midpoint of $\overline{M_2 M_3}$

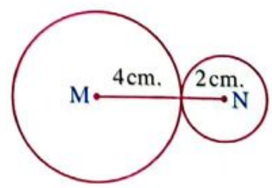
(c) on the axis of symmetry $\overline{M_2 M_3}$ above M_1

(d) on the axis of symmetry $\overline{M_2 M_3}$ under M_1

---

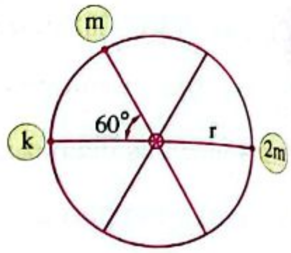
83 **In the opposite figure :**

Two fine uniform circular discs are connected in the same plane and the mass of one unit of area from circle N is twice the mass of one unit of area from circle M , then the centre of gravity of the figure lies at a distance .... cm. from M.



(a) 1.5 (b) 2 (c) 3 (d) 4

84 The opposite figure represents a light wheel whose radius length is r , can rotate in a vertical plane around a horizontal smooth axis , three masses m , 2 m , k are fixed on it , then wheel is in equilibrium as shown in the figure , then the value of k in term of m is ....



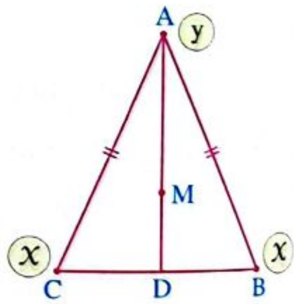
(a) $\frac{1}{2}$ m (b) m (c) $\frac{3}{2}$ m (d) 2 m

85 A fine lamina of uniform thickness and density. It has two axes of symmetry , then the centre of gravity of this lamina ....

(a) lies on just one of the two axes.
(b) lies on the intersection point of the two axes.
(c) does not lie on any of the two axes.
(d) the givens are not sufficient to determine the position of the centre of gravity.

86 **In the opposite figure :**

Δ ABC is an isosceles triangle M is the point of intersection of its medians. Masses y , x , x has been attached to its vertices then the relation between the values of y , x which makes the centre of gravity of the system lies at the midpoint of $\overline{DM}$ is ....



(a) $y = x$ (b) $5y = 2x$ (c) $5x = 2y$ (d) $y = 2x$

87 Two solid spheres of a uniform density and touching each other externally , their radii 6 cm. , 3 cm. The centre of gravity of their resultant solid is at a distance .... from the centre of the greater sphere.

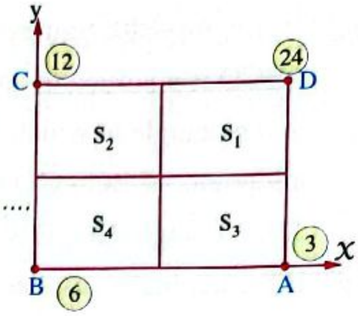
(a) 1 cm. (b) 2 cm. (c) 3 cm. (d) 4 cm.

88 The distance between the centre of gravity of a lamina of uniform thickness and density in form of a uniform hexagon , its side length is 6 cm. , from one of its vertices equals .... cm.

(a) 12 (b) 6 (c) 4 (d) 3

89 **In the opposite figure :**

ABCD is a rectangle , it is divided into 4 congruent sections S_1 , S_2 , S_3 , S_4 . Masses 3 , 6 , 12 , 24 kg. are fixed as shown in the figure , then the centre of gravity of the system lies in ....



(a) S_1 (b) S_2

(c) S_3 (d) S_4

---

90 A body formed from a solid cylinder whose radius length r and its height = r , topped by a semi-sphere of radius r , then the centre of gravity lies ....

(a) inside the cylinder.

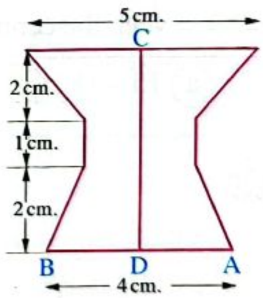
(b) inside the semi-sphere.

(c) on the surface between the cylinder and the semi-sphere.

(d) outside both solids.

---

91 The opposite figure represents a fine lamina of a uniform thickness and density and symmetric about the axis $\overleftrightarrow{CD}$ and its dimensions as in the figure and ℓ is the distance of the centre of gravity of the lamina from $\overline{AB}$, then which of the following is true ?

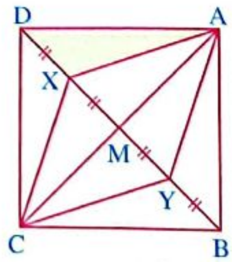


(a) $\ell = 2$ (b) $2 < \ell < 2\frac{1}{2}$

(c) $\ell = 2\frac{1}{2}$ (d) $2\frac{1}{2} < \ell < 4$

---

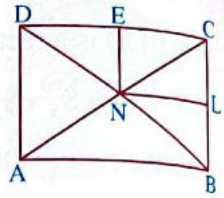
92 ABCD is a square, its centre is M , BY = YM = MX = XD , Δ AXD has been removed. Which of the following triangles should be removed also to keep the centre of gravity at M ?



(a) ABY (b) BYC

(c) DXC (d) AMX

93 **In the opposite figure :**



ABCD is a lamina of a uniform thickness and density in the form of a rectangle in which AB = 12 cm. , BC = 8 cm. If L , E are the midpoints of $\overline{BC}$, $\overline{CD}$ respectively , $\overline{AC} \cap \overline{BD} = \{N\}$

The rectangle NLCE is cut off from the lamina.

If the lamina is suspended freely from A , then the tangent of the inclination angle of $\overline{AB}$ to the vertical in the equilibrium position = ...

(a) $\frac{2}{3}$ (b) $\frac{3}{4}$ (c) $\frac{4}{5}$ (d) $\frac{5}{6}$

---

94 A wire of a uniform thickness and density in the form of an isosceles trapezium ABCD in which $\overline{AD} \,//\, \overline{BC}$ and AD = 3 cm. , DC = 5 cm. , CB = 9 cm. If the wire is suspended freely from A , then tangent of the measure of the angle of inclination of $\overline{AD}$ to the vertical in the equilibrium position = ...

(a) $\frac{56}{33}$ (b) $\frac{33}{56}$ (c) $\frac{33}{28}$ (d) $\frac{28}{33}$

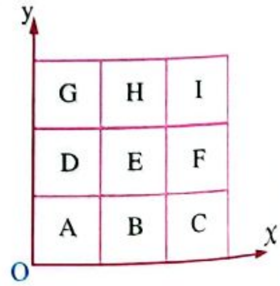
---

95 A fine lamina of a uniform thickness and density in the form of a square ABCD of side length 48 cm. and M is the intersection point of its diagonals. The triangle CMD is cut off , then stuck on the triangle CMB such that $\overline{MD}$ is coincident to $\overline{MB}$. Then the distance between the centre of gravity of the lamina and both $\overline{BA}$ and $\overline{BC}$ equals ....

(a) 15 , 15 (b) 20 , 20 (c) 24 , 24 (d) 20 , 24

---

96 **In the opposite figure :**



A uniform lamina is bounded by a square of side length 6 cm. it is divided into nine congruent squares , then choose the correct answer from those given :

First : If the square (E) is cut off , then the centre of gravity is ....

(a) (2 , 2) (b) (1 , 1) (c) (6 , 6) (d) (3 , 3)

Second : If the squares (C) , (I) are cut off , then the centre of gravity is ....

(a) (1 , 1) (b) (1 , 2) (c) $\left(\frac{17}{7}, 3\right)$ (d) (2 , 1)

Third : If the square (E) is cut off and stuck on the square (B) , then the centre of gravity is ....

(a) $\left(3, \frac{25}{9}\right)$ (b) $\left(3, \frac{29}{9}\right)$ (c) (3 , 2) (d) $\left(\frac{25}{9}, 3\right)$

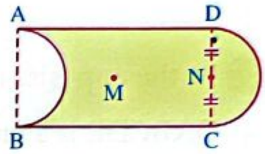
97 A fine uniform lamina of mass (5 m) and centre lies at the point (3 , 6) , A part of mass (m) has centre of gravity at (2 , 4) is cut out of the lamina then the centre of gravity of the remaining part lies on the straight line ....

(a) $y = x$ (b) $y = 2x$ (c) $x + y = 10$ (d) $2x + y = 4$

---

98 **In the opposite figure :**

A lamina of uniform thickness and density in form of a rectangle ABCD. AB = 2 cm. , BC = π cm. A semicircle with diameter $\overline{AB}$ is cut out and a semicircle with diameter $\overline{DC}$ is added to the lamina (as shown in the figure) If M is the point of intersection of the diagonals of the rectangle , N is the midpoint of $\overline{CD}$ If F $\in \overline{MN}$ is the centre of gravity of the lamina , then $\frac{NF}{MN}$ = ...

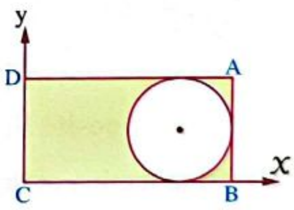


(a) $\frac{1}{8}$ (b) $\frac{3}{8}$ (c) $\frac{1}{2}$ (d) $\frac{5}{8}$

---

99 **In the opposite figure :**

A fine lamina of uniform thickness and density in form of rectangle ABCD where AB = 20 cm. , BC = 40 cm. A circular disk touches three sides of the rectangle is removed as shown in the figure then the remaining part is suspended from C , then the tangent of the angle between $\overrightarrow{CB}$ and the vertical = ... $\left(\pi = \frac{22}{7}\right)$

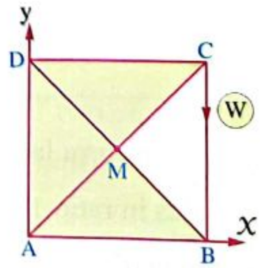


(a) $\frac{15}{23}$ (b) $\frac{23}{17}$ (c) $\frac{17}{23}$ (d) $\frac{20}{17}$

---

100 **In the opposite figure :**

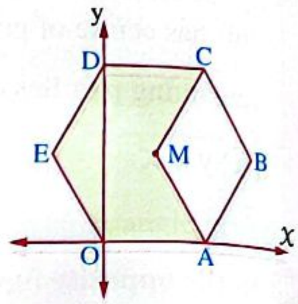
ABCD is a uniform square of side length 18 cm. and weight 40 N. M is the point of intersection of its diagonals the triangle MBC is removed and a body of weight (w) is fixed at C and the system is hanged from A. If $\overline{AB}$ makes with the vertical an angle of tangent $\frac{6}{5}$, then W = ... N.



(a) 5 (b) 10 (c) 15 (d) 20

101 **In the opposite figure :**

ABCDEO is a uniform hexagon its centre is (M) and its side length 12 cm. Rhombus MABC is a rhombus is removed , then the centre of the remaining part is ....



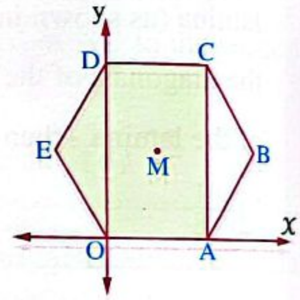
(a) $\left(\frac{7}{2} , 6\sqrt{3}\right)$ (b) $\left(\frac{4}{5} , \frac{6\sqrt{3}}{5}\right)$

(c) $\left(3 , 6\sqrt{3}\right)$ (d) $\left(5 , 6\sqrt{3}\right)$

---

102 **In the opposite figure :**

OABCDE is a uniform hexagon its side length is 18 cm. and has weight 60 N. the centre of gravity of the hexagon is (M). Triangle ABC is removed , then a mass (m) is fixed at the midpoint of $\overline{AC}$ such that the centre of gravity remains at (M) , then m = ... N.



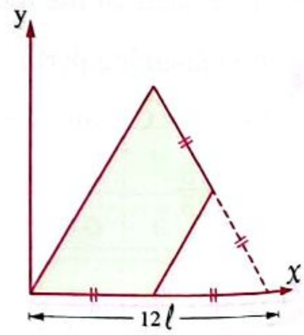
(a) $\frac{50}{3}$ (b) $\frac{40}{3}$

(c) $\frac{35}{3}$ (d) $\frac{25}{3}$

---

103 **In the opposite figure :**

A fine lamina of uniform thickness and density in form of an equilateral triangle. An equilateral triangle has been removed from the original one , then the centre of gravity of the remaining trapezium is ....



(a) $\left(5\ell , \frac{7}{3}\sqrt{3}\ell\right)$ (b) $\left(5\ell , 5\ell\right)$

(c) $\left(5\ell , 5\sqrt{3}\ell\right)$ (d) $\left(5\ell , 6\ell\right)$

---

104 If a uniform lamina in form of a square has been suspended from a point divides one of its sides in ratio 1 : 3 from one of its ends , then the inclination angle between this side with the vertical is ....

(a) $\sin^{-1}\frac{1}{2}$ (b) $\sin^{-1}\frac{1}{3}$ (c) $\tan^{-1} 2$ (d) $\tan^{-1} 3$

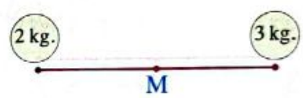
105 ABCD is a non-uniform lamina in form of a square. If the inclination angle between $\overline{AB}$ with the vertical when it is suspended from A and B respectively are $\tan^{-1}\frac{1}{2}$ and $\tan^{-1}\frac{1}{2}$, then the inclination angle between $\overline{BC}$ with the vertical when it is suspended from C is ....

(a) $\tan^{-1}\frac{1}{4}$ (b) $\tan^{-1}\frac{1}{2}$ (c) $\tan^{-1}\frac{2}{3}$ (d) $\tan^{-1}\frac{1}{3}$

106 A uniform wire of length 100 cm. is bent in the form of five sides of a regular hexagon ABCDEF starting from point A , then the distance between the centre of gravity of the wire and the centre of the hexagon = ... cm.

(a) $2\sqrt{3}$ (b) $3\sqrt{2}$ (c) 3 (d) 2

107 Two bodies of masses 3 kg. , 2 kg. are placed on a straight line. If the body of mass 3 kg. has been moved 10 cm. towards their centre of gravity M. and the other body has been moved S cm. towards the centre of gravity to keep their centre of gravity at the same position , then S = ... cm.



(a) 5 (b) -1 (c) 15 (d) 20

108 **In the opposite figure :**

A system consists of two bodies , their masses are 2 kg. , 4 kg. placed at A and B. If the mass 4 kg. has been moved in $\overrightarrow{AB}$ direction 5 cm. , then the distance which the mass 2 kg. has to be moved to keep the position of center of gravity unchanged is ....

(a) 2.5 cm. in $\overrightarrow{AB}$ direction. (b) 2.5 cm. in $\overrightarrow{BA}$ direction.

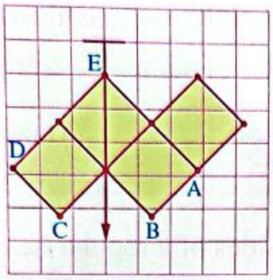
(c) 10 cm. in $\overrightarrow{AB}$ direction. (d) 10 cm. in $\overrightarrow{BA}$ direction.

109 A system consists of two laminas equal in thickness and density in form of two circles touching externally. If their equations are $C_1 : x^2 + y^2 - 2x = 8$, $C_2 : (x - 10)^2 + y^2 = K$, then the centre of gravity of the system is ....

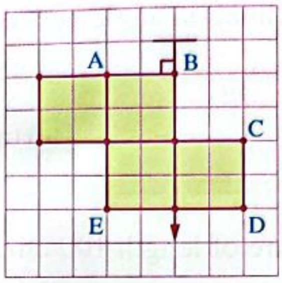
(a) inside C_1 (b) inside C_2

(c) at the touching point. (d) outside the two circles.

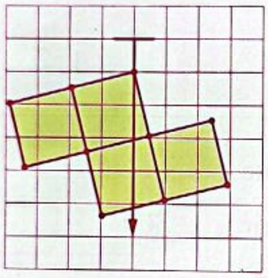
110 A lamina made from four squares from the same material and have same thickness and density suspended from the ceiling. Which of the following refers to the lamina in equilibrium position ?



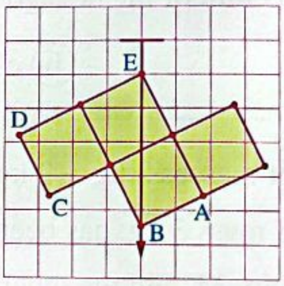
(a)



(b)



(c)



(d)

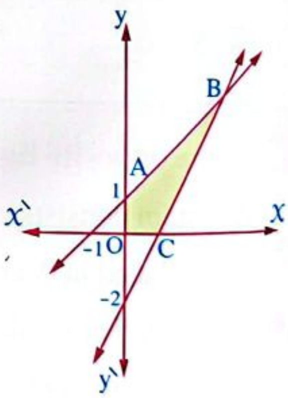
111 In the opposite figure :

If the equation of the straight line $\overleftrightarrow{AB}$ is $y = x + 1$

, the equation of the straight line $\overleftrightarrow{CB}$ is $y = 2x - 2$

Assume that the region OABC of uniform density and thickness

, then its centre of gravity is ....



(a) $\left(\frac{6}{7}, \frac{5}{7}\right)$ (b) $\left(\frac{25}{21}, \frac{31}{21}\right)$

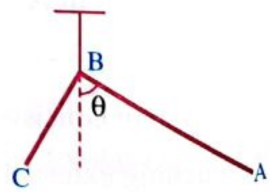
(c) $\left(\frac{4}{7}, \frac{6}{7}\right)$ (d) $\left(\frac{25}{21}, \frac{5}{7}\right)$

112 In the opposite figure :

$\overline{ABC}$ is a uniform rod of length 280 cm. its bent at B as shown in the diagram such that m (∠ ABC) = 90°

If the rod is suspended from B , then $\overleftrightarrow{AB}$ makes with the vertical an angle its tangent = $\frac{4}{9}$ with the vertical

, then BC = ... cm.

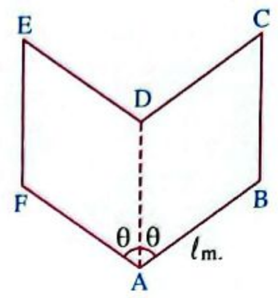


(a) 112 (b) 120 (c) 130 (d) 132

113 In the opposite figure :

A uniform lamina in form of two rhombuses sharing in $\overline{AD}$. If the side length of the rhombus = ℓ m. , m ($\angle$ DAB) = θ and the centre of gravity of the system above A by (0.9 ℓ) m.

, then $\cos\theta$ = ...

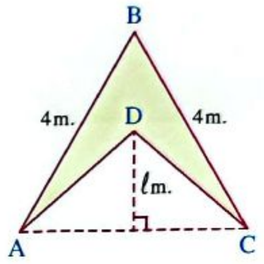


(a) $\frac{3}{5}$ (b) $\frac{4}{5}$

(c) $\frac{4}{3}$ (d) $\frac{3}{4}$

114 In the opposite figure :

A lamina of uniform density in form of an equilateral triangle ABC of side length 4 m. An isosceles triangle ADC of height (ℓ) m. has been removed from it where $\ell < 2\sqrt{3}$, if the centre of gravity of the remaining lamina ABCD at the point D , then ℓ = ... m.

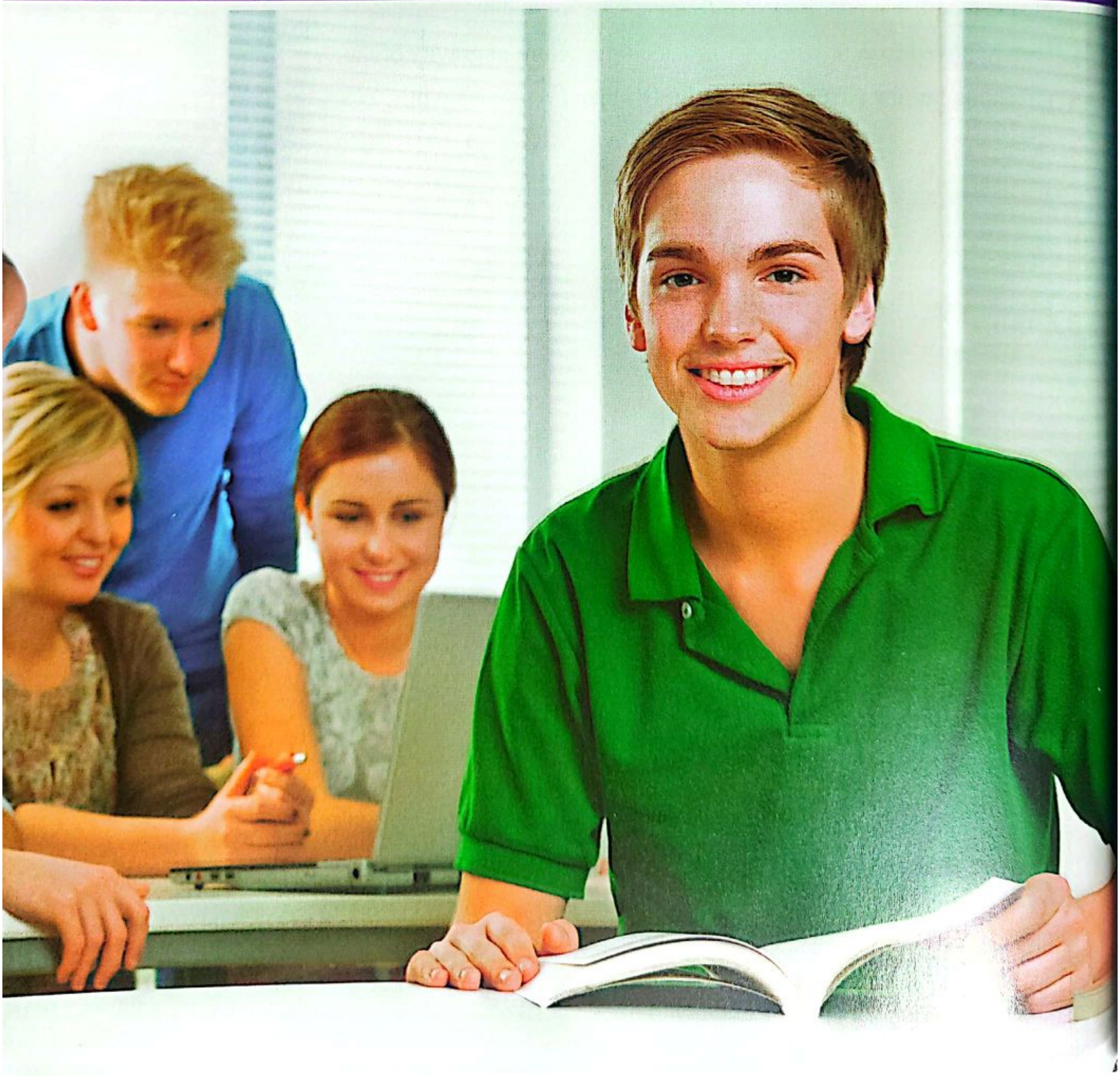


(a) 1 (b) $\sqrt{3}$ (c) 2 (d) $2\sqrt{3}$

Practice Exams

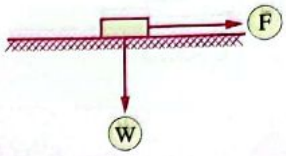
on

Statics



Answer the following questions :

1 **In the opposite figure :**

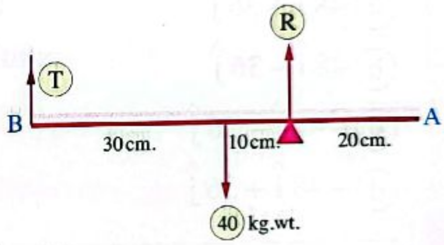


A horizontal force $\vec{F}$ (where F measured in newton) acts on a body of weight (W) newton placed on a rough horizontal plane , if the measure of the angle between the weight $\overrightarrow{W}$ and the resultant reaction $\vec{R}$ is θ , then the resultant reaction $\dot{R}$ = ... newton.

(a) $-W \sin\theta$ (b) $-W \sec\theta$ (c) $W \cos\theta$ (d) $W \csc\theta$

---

2 **In the opposite figure :**



$\overline{AB}$ is a uniform rod of length 60 cm.

and of weight 40 kg.wt. , if the rod rests horizontally on a support at a distance 20 cm. from A and suspended from the end B by a light string , then R – T = ... kg.wt.

(a) 40 (b) 30 (c) 10 (d) 20

---

3 If the force $\vec{F} = 2\hat{i} - 3\hat{j}$ and the equation of its line of action is $3x + 2y = 0$, then the moment of the force $\vec{F}$ about the point A (1 , 2) equals .... $\hat{k}$

(a) –7 (b) 7 (c) –1 (d) 1

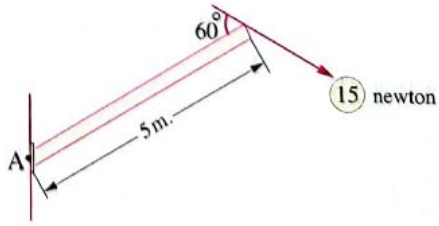
---

4 If a system of forces acting on the plane of square ABCD form a couple the norm of its moment equals 40 newton.cm. , then $\|\overrightarrow{M}_A\| + \|\overrightarrow{M}_B\| + 3\|\overrightarrow{M}_C\| - \|\overrightarrow{M}_D\| =$ ....

(a) 240 (b) 80 (c) 120 (d) 160

---

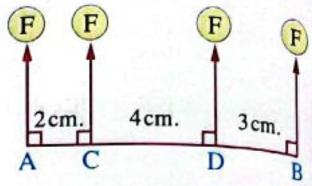
5 **In the opposite figure :**



The algebraic measure of moment of the force whose magnitude = 15 newton about the point A equals .... newton.m.

(a) 75 (b) $\frac{75\sqrt{3}}{2}$ (c) $\frac{75}{2}$ (d) $75\sqrt{3}$

6 In the opposite figure :

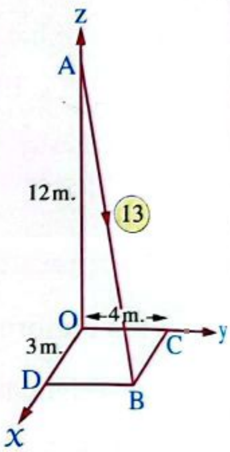


If the resultant of these forces acts at point $M \in \overline{AB}$, then BM = ... cm.

(a) 2.25 (b) 3.25

(c) 3.75 (d) 4.75

7 In the opposite figure :



A flag pole of height 12 metre is pulled by a force $\vec{F}$ of magnitude 13 newton acts in the direction of $\overrightarrow{AB}$, then the moment vector of the force $\vec{F}$ about the origin point = ...

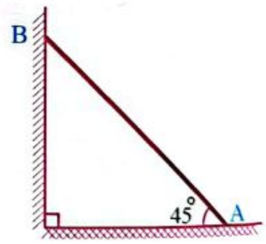
(a) $48\,\hat{i} + 36\,\hat{j}$

(b) $48\,\hat{i} - 36\,\hat{j}$

(c) $-48\,\hat{i} - 36\,\hat{j}$

(d) $-48\,\hat{i} + 36\,\hat{j}$

8 In the opposite figure :



$\overline{AB}$ is a non-uniform ladder of length 4 metre and weight 200 newton rests with its end A on a rough horizontal ground, the coefficient of static friction between them is $\frac{3}{5}$ and its end B rests against a smooth vertical wall. If the ladder is about to slide when it inclined to the horizontal by an angle of measure 45°, then the point of action of its weight is at a distance .... cm. from A

(a) 120 (b) 200 (c) 240 (d) 100

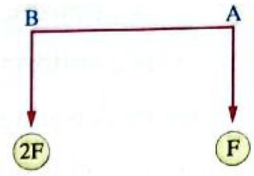
9 ABCDEO is a regular hexagon whose length ℓ cm., forces of magnitudes $10\sqrt{3}$, 6, $10\sqrt{3}$, 6 newton act along $\overrightarrow{AB}$, $\overrightarrow{DB}$, $\overrightarrow{DE}$, $\overrightarrow{AE}$ respectively. If the system tends to a couple, then the magnitude of its moment = ... newton.cm.

(a) $24\,\ell$ (b) $36\,\ell$ (c) $36\sqrt{3}\,\ell$ (d) $24\sqrt{3}\,\ell$

10 If $4\,\overrightarrow{F_1}$, $3\,\overrightarrow{F_2}$ are two forces of a couple and $\overrightarrow{F_1} = 6\,\hat{i} - 9\,\hat{j}$, then $\overrightarrow{F_2}$ = ...

(a) $-8\,\hat{i} + 12\,\hat{j}$ (b) $8\,\hat{i} - 12\,\hat{j}$ (c) $12\,\hat{i} - 8\,\hat{j}$ (d) $-12\,\hat{i} + 8\,\hat{j}$

11 **In the opposite figure :**

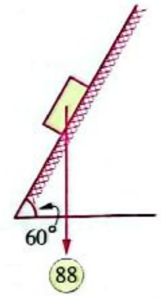


Two parallel forces in the same direction of magnitudes F , 2F newton act at A and B , where AB = 60 cm. and the point of action of their resultant $\in \overline{AB}$ if the two forces exchange their positions , then the point of action of the resultant moves a distance = ... cm.

(a) 10 (b) 20 (c) 30 (d) 40

---

12 **In the opposite figure :**



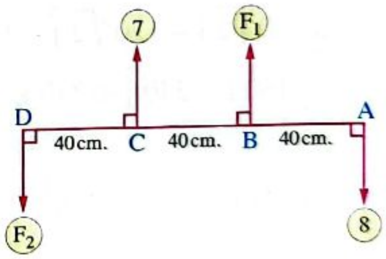
A body of weight 88 newton is placed on a rough inclined plane makes an angle of measure 60° to the horizontal , if the body is about to slide , then the magnitude of the limiting static friction force = ... newton.

(a) $22\sqrt{3}$ (b) $44\sqrt{3}$

(c) 44 (d) 22

---

13 **In the opposite figure :**

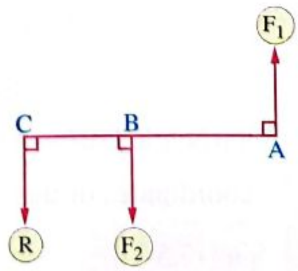


A , B , C and D are four points lying on the same horizontal straight line such that AB = BC = CD = 40 cm. the parallel forces of magnitudes 8 , F_1 , 7 and F_2 newton act as shown in the figure. If the magnitude of their resultant = 6 newton and acts vertically downward at the point M where M is the midpoint of $\overline{AD}$, then $F_1 + F_2$ = ... newton.

(a) 12 (b) 10 (c) 13 (d) 16

---

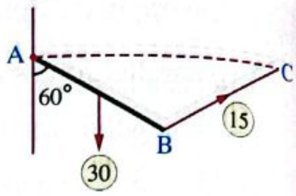
14 **In the opposite figure :**



$\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces act at the two points A , B If their resultant acts at the point C , where $C \in \overrightarrow{AB}$, AB : AC = 4 : 7 and the magnitude of their resultant is 20 gm.wt. , then F_1 = ... gm.wt.

(a) 35 (b) 20 (c) 25 (d) 15

15 **In the opposite figure :**

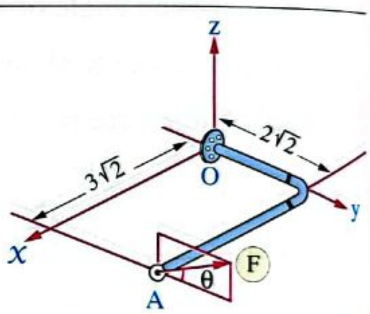


$\overline{AB}$ is a uniform rod of weight 30 N.
Its end A is hinged to a vertical wall and its end B is tied to a light inextensible string. The other end of the string is tied to point C lies on the same horizontal plane as A , the rod is in equilibrium when the tension in the string is 15 N. If AB = BC and the points A , B and C lies in the same vertical plane perpendicular to the wall and the rod inclined to the wall at an angle of measure 60° , then the reaction of the hinge inclined to $\overline{AC}$ at an angle of measure ....°

(a) zero (b) 90 (c) 120 (d) 180

---

16 **In the opposite figure :**



Force $\vec{F}$ of magnitude 80 N. acts on the rod at A where $\vec{F}$ inclined on the x y-plane at an angle θ of measure 45° and the force is parallel to the y z-plane , then the moment of the force $\vec{F}$ about O = ...

(a) $80\sqrt{2}\,\hat{i} - 120\sqrt{2}\,\hat{j} - 120\sqrt{2}\,\hat{k}$ (b) $40\sqrt{2}\,\hat{i} + 120\sqrt{2}\,\hat{j} + 80\sqrt{2}\,\hat{k}$

(c) $160\,\hat{i} - 240\,\hat{j} + 240\,\hat{k}$ (d) $240\,\hat{i} - 160\,\hat{j} - 240\,\hat{k}$

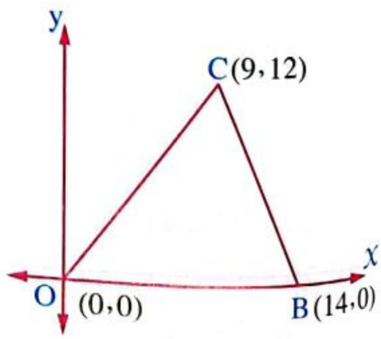
---

17 A body of weight 10 newton is placed on a horizontal rough plane , and the coefficient of the static friction between the body and the plane = $\frac{1}{\sqrt{5}}$. If the body is pulled by a horizontal force , then the magnitude of the static friction force ∈ ....

(a) $]0 , 2\sqrt{5}[$ (b) $[0 , 2\sqrt{5}[$ (c) $]0 , 2\sqrt{5}]$ (d) $[0 , 2\sqrt{5}]$

---

18 **In the opposite figure :**



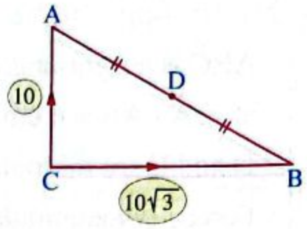
A thin wire of uniform thickness and density in the form of a triangle OBC , where B (14 , 0) and C (9 , 12) , then the coordinates of the centre of gravity of the wire is ....

(a) (7.5 , 4) (b) (4 , 7)

(c) (4.5 , 7) (d) (7 , 4.5)

Scanned with CamScanner

19 **In the opposite figure :**



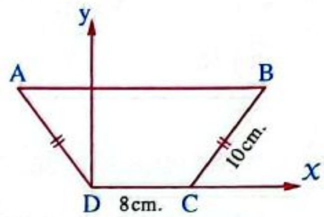
ABC is a triangle , m (∠ A) = 2 m (∠ B)

, D is the midpoint of $\overline{AB}$ two forces 10 N. , $10\sqrt{3}$ N. acts in $\overrightarrow{CA}$, $\overrightarrow{CB}$ respectively if the resultant of the two forces passes through D , then m (∠ B) = ...°

(a) 90 (b) 60 (c) 45 (d) 30

---

20 **In the opposite figure :**



A uniform thin lamina ABCD in the shape of isosceles trapezium in which $\overline{AB}$ // $\overline{DC}$

, AB = 2 BC = 20 cm. , CD = 8 cm. , then the centre of gravity of the lamina = ...

(a) $\left(\frac{10}{3} , \frac{32}{7}\right)$ (b) (4 , 32) (c) $\left(10 , \frac{16}{3}\right)$ (d) $\left(4 , \frac{32}{7}\right)$

---

21 A body of weight 39 kg.wt. is placed on a horizontal rough plane , two forces in the same horizontal plane of the body of magnitude 5 , 12 kg.wt. and the measure of angle between them 90° act on it to make the body about to move , then the coefficient of the static friction between the body and the plane = ...

(a) $\frac{1}{3}$ (b) $\frac{1}{2}$ (c) $\frac{1}{4}$ (d) $\frac{1}{5}$

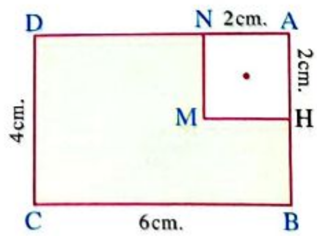
---

22 Two masses 8 , (k) kg. are placed at the two points A and B respectively where AB = 40 cm. , if the centre of gravity of the two masses acts at the point C where C ∈ $\overline{AB}$ and AC = 24 cm. , then k = ... kg.

(a) 8 (b) 12 (c) 16 (d) 24

---

23 **In the opposite figure :**

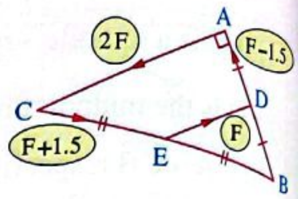


A fine lamina of a uniform thickness and density in the form of a rectangle ABCD whose dimensions are 6 cm. , 4 cm. if the square AHMN of side length 2 cm. is cut off as shown in the figure , then the distance between the centre of gravity of the remaining part and each of $\overleftrightarrow{CD}$, $\overleftrightarrow{CB}$ respectively is ....

(a) 2.6 cm. , 2.4 cm. (b) 2.6 cm. , 1.8 cm.

(c) 1.8 cm. , 2.6 cm. (d) 2.4 cm. , 2.6 cm.

24 In the opposite figure :

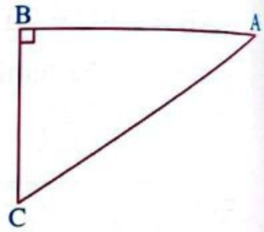


ABC is a right-angled triangle at $\angle A$, AB = 6 cm. , AC = 8 cm.
D and E are midpoints of $\overline{AB}$ and $\overline{BC}$
Forces of magnitudes 2F , F , (F + 1.5) , (F – 1.5) newtons acts in $\overrightarrow{AC}$, $\overrightarrow{ED}$, $\overrightarrow{CE}$, $\overrightarrow{DA}$ directions respectively.
If the system is equivalent to a couple , then the magnitude of its moment = ... N.cm.

(a) 36 (b) 54 (c) 72 (d) 108

---

25 In the opposite figure :

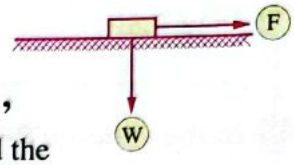


A fine lamina of a uniform thickness and density in the form of a right-angled triangle at B and of weight 30 kg.wt. where AB = 9 cm. , BC = 6 cm. the lamina is suspended in a pin at a small hole near to the vertex B , a couple in its plane acted on it to make it in equilibrium when $\overline{AB}$ is horizontal , then the algebraic measure of the moment of the couple = ... kg.wt.cm.

(a) 135 (b) – 90 (c) – 135 (d) 90

Answer the following questions :

1 In the opposite figure :



A body of weight (W) newton is placed on a rough horizontal plane , where the sine of the angle of limiting friction between the body and the plane = $\frac{4}{5}$, a horizontal force $\vec{F}$ acts on the body to make it about to move , if the magnitude of the friction force (measured by newton) $\in]0 , 12]$, then the weight of the body = ... newton.

(a) 9 (b) 15 (c) 9.6 (d) 16

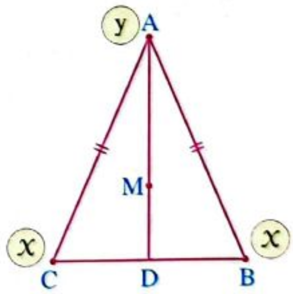
---

2 F_1 and F_2 are two parallel forces acting at A , B respectively where $F_1 = 30$ kg.wt. , $F_1 > F_2$ and their resultant R of magnitude 10 kg.wt. and acts at C where BC = 90 cm. , then AB = ... cm.

(a) 30 (b) 45 (c) 60 (d) 120

---

3 In the opposite figure :



Δ ABC is an isosceles triangle

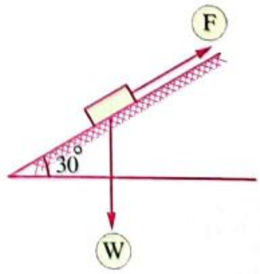
M is the point of intersection of its medians.

Masses y , x , x has been attached to its vertices , then the relation between the values of y , x which makes the centre of gravity of the system lies at the midpoint of $\overline{DM}$ is ....

(a) $y = x$ (b) $5y = 2x$ (c) $5x = 2y$ (d) $y = 2x$

---

4 In the opposite figure :



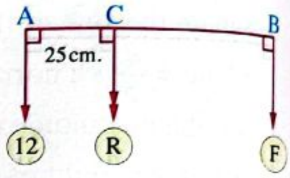
A body of weight (W) newton is placed on a rough plane inclined to the horizontal by an angle of measure 30° , a force of magnitude F newton in the direction of the line of the greatest slope upwards the plane acts on it to make the body about to move upwards when the magnitude of the resultant reaction between the body and the plane equals (W) newton , then F = ... newton.

(a) W (b) $\frac{\sqrt{3}}{2}$ W (c) $\frac{1}{2}$ W (d) $\sqrt{3}$ W

5 If the force $\vec{F} = \hat{i} - 2\hat{j} + 4\hat{k}$ acts at the point B where B lies on y-axis. If the norm of the moment of $\vec{F}$ about the origin point $= \sqrt{85}$ moment unit , then the y-coordinate of the point B = ...

(a) ± 2.5 (b) $\pm\sqrt{3}$ (c) $\pm\sqrt{5}$ (d) ± 5

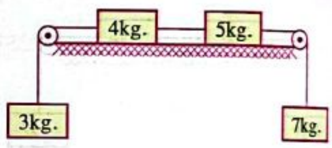
6 **In the opposite figure :**



The two forces F , 12 newton are parallel and the magnitude of their resultant is R , if AB = 75 cm. , AC = 25 cm. , then F and R respectively are .... , ... newton.

(a) 18 , 30 (b) 4 , 16 (c) 16 , 28 (d) 6 , 18

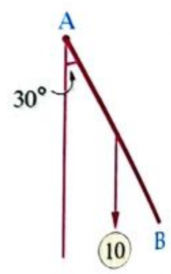
7 **In the opposite figure :**



Two masses 5 kg. and 4 kg. are of the same material. If the system is about to move and the plane is rough , then coefficient of static friction = ...

(a) $\frac{7}{9}$ (b) $\frac{4}{9}$ (c) $\frac{5}{7}$ (d) $\frac{3}{4}$

8 **In the opposite figure :**



$\overline{AB}$ is a uniform rod of length 2 m. and weight 10 kg.wt. acts at its midpoint. The rod is hinged at A to a vertical wall. A couple acts on the rod perpendicular to vertical plane passes through the rod and the magnitude of its moment = 10 kg.wt.m.

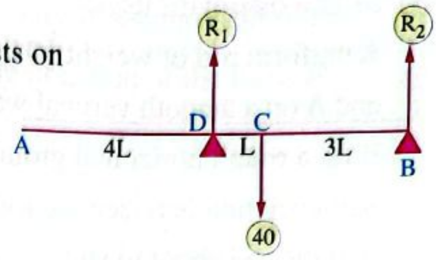
If the rod is in equilibrium when it makes an angle of measure 30° to the vertical when a body of mass .... kg. is suspended from the other end (B)

(a) 5 (b) 10 (c) $5\sqrt{3}$ (d) $10\sqrt{3}$

9 If $\vec{F_1} = (a , -3)$, $\vec{F_2} = (1 , 1)$ and $\vec{F_3} = (1 , b - a)$ are equivalent to a couple , then a + b = ...

(a) -1 (b) -2 (c) 1 (d) 3

10 **In the opposite figure :**



$\overline{AB}$ is a non-uniform rod of weight 40 kg.wt. acts at C rests on two supports at B and D. If the rod equilibrated horizontally , then $R_1 - R_2 =$ .... kg.wt.

(a) 20 (b) 10 (c) 25 (d) 30

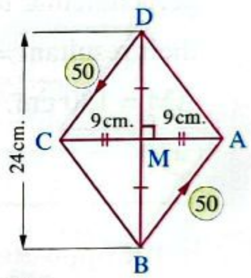
---

11 Two masses m kg. , 14 kg. are placed at the two points A and B respectively where AB = 20 m. , if the centre of gravity of the two masses acts at the point C where $C \in \overline{AB}$ and CB = 6 m. , then m = ... kg.

(a) 7 (b) 8 (c) 14 (d) 6

---

12 **In the opposite figure :**

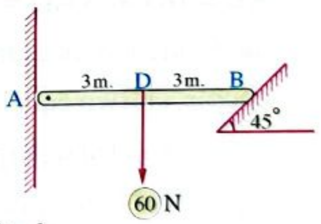


ABCD is a rhombus two forces each of magnitude 50 newton acts along $\overrightarrow{BA}$, $\overrightarrow{DC}$, then the algebraic measure of the moment of the couple = ... N.cm.

(a) 450 (b) 720 (c) 900 (d) 1200

---

13 **In the opposite figure :**



$\overline{AB}$ is a uniform rod of length 6 m. and of weight 60 newton its end A is attached to a fixed hinge at a vertical wall and its end B rests against a smooth plane inclined to the horizontal by an angle of measure 45° , if the rod equilibrated then the magnitude of the reaction at the hinge (A) = ... newton.

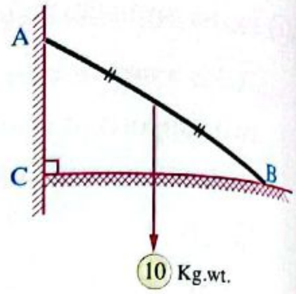
(a) $15\sqrt{2}$ (b) $30\sqrt{2}$ (c) 30 (d) 15

---

14 $\overline{AB}$ is a board of wood of length 20 metre and weight 50 kg.wt. acting at its midpoint. It is supported horizontally on two supporters one of them is at a distance 2 metre from A and the other is at a distance 5 metres from B. If a man of weight 70 kg.wt. walks on the board starting from A towards B , then the maximum distance which the man can cover on the board without turning over to the board = ... m.

(a) $3\frac{4}{7}$ (b) 8 (c) 15 (d) $18\frac{4}{7}$

15 **In the opposite figure :**

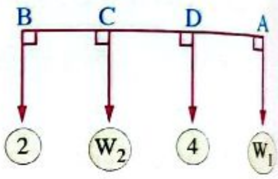


A uniform rod of weight 10 kg.wt. rests with its end A on a smooth vertical wall and with its end B on a rough horizontal ground the coefficient of static friction between the rod and the ground is $\frac{1}{2}$ and the rod about to slide , then the reaction of the wall on the rod = ...kg.wt.

(a) 2.5 (b) 5 (c) 10 (d) 20

---

16 **In the opposite figure :**

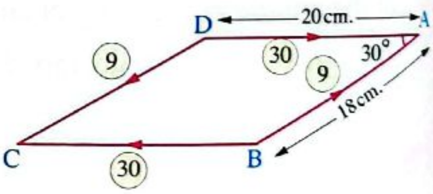


$\overline{AB}$ is a light ruler of negligible weight and of length 300 cm. , forces of magnitudes W_1 , 4 , W_2 and 2 gm.wt. act in a direction perpendicular to $\overline{AB}$ where AD = DC = CB. If the magnitude of their resultant = 10 gm.wt. and acts at the point M where AM = 130 cm. , then $W_1 - W_2$ = ... gm.wt.

(a) 1 (b) 2 (c) 3.5 (d) 4

---

17 **In the opposite figure :**

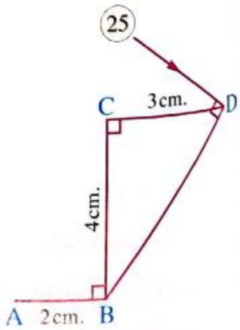


ABCD is a parallelogram in which m (∠ A) = 30° , AB = 18 cm. , AD = 20 cm. , the forces as shown in the figure are measured in gm.wt.act to form resultant couple , if two equal forces F , F gm.wt. act at the two points A , D and perpendicular to $\overline{AD}$ to form a couple equivalent to the previous couple , then the magnitude of F = ... gm.wt.

(a) 18 (b) 30 (c) 10 (d) 9

---

18 **In the opposite figure :**



A force $\vec{F}$ of magnitude 25 newton acts at the point D such that $\vec{F} \perp \overline{DB}$, if DC = 3 cm. , BC = 4 cm. , AB = 2 cm. , then the algebraic measure of the moment of the force $\vec{F}$ about the point A equals .... newton.cm.

(a) 125 (b) 155

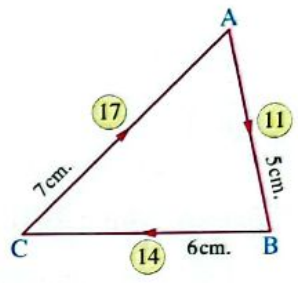
(c) – 155 (d) – 125

19 If the force $\overrightarrow{F} = 3\hat{i} + 2\hat{j}$ acts at a certain point, and the vector of the moment of the force $\overrightarrow{F}$ about the origin point O equals $15\hat{k}$, then the line of action of the force $\overrightarrow{F}$ intersects y-axis at the point ....

(a) (0, –5) (b) (0, 15) (c) (0, 5) (d) (0, –15)

---

20 **In the opposite figure :**

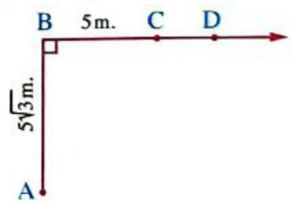


ABC is a triangle in which AB = 5 cm., BC = 6 cm., AC = 7 cm., the shown forces in the figure measured in newton. If a force of magnitude F newton is added to each force to make the system equivalent to a couple, then the algebraic measure of the moment couple = ... newton.

(a) $-36\sqrt{6}$ (b) $36\sqrt{6}$ (c) 72 (d) –72

---

21 **In the opposite figure :**



$\overline{AB} \perp \overline{BD}$, $AB = 5\sqrt{3}$ m., BC = 5 cm.

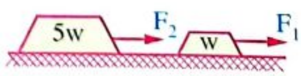
Force $\overrightarrow{F}$ acts at point C and acts in direction inclined to $\overrightarrow{CD}$ at an angle θ downward.

If the moment of the force $\overrightarrow{F}$ vanished about the point A, then measure of angle θ = ...°

(a) 30 (b) 60 (c) 120 (d) 150

---

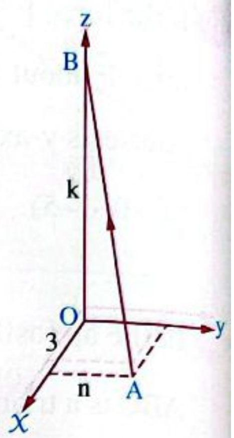
22 **In the opposite figure :**



Two bodies of weights W, 5 W are made of the same material and placed on the same rough horizontal plane. If the limiting force friction between the two bodies and the plane are F_1, F_2 respectively, then ....

(a) $F_1 = F_2$ (b) $F_2 = 5\,F_1$ (c) $F_2 = \frac{1}{5}\,F_1$ (d) $F_1 + F_2 = 6\,W$

23 **In the opposite figure :**



A force of magnitude $10\sqrt{2}$ newton acts in $\overrightarrow{AB}$ where $\|\overrightarrow{AB}\| = 5\sqrt{2}$, if the moment vector of the force $\overrightarrow{F}$ about the origin point O is $\overrightarrow{M_o} = 30\,\hat{j} - 40\,\hat{i}$

, then $k + n =$ ....

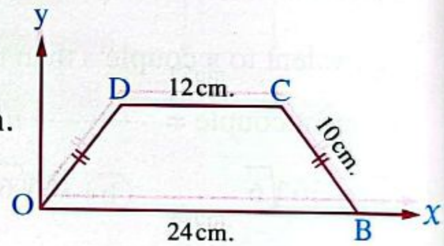
(a) -1

(b) 1

(c) -9

(d) 9

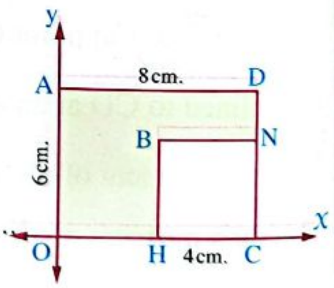
24 **In the opposite figure :**



A wire of a uniform thickness and density in the shape of trapezium OBCD in which $\overline{CD} \,//\, \overline{BO}$, OD = BC = 10 cm. , CD = 12 cm. , OB = 24 cm. , then the centre of gravity of the wire is ....

(a) $\left(12 , \frac{22}{7}\right)$ (b) $\left(\frac{22}{7} , 12\right)$ (c) $\left(10 , \frac{22}{7}\right)$ (d) $\left(\frac{22}{7} , 10\right)$

25 **In the opposite figure :**



AOCD is a fine lamina of a uniform thickness and density in the form of a rectangle in which AO = 6 cm. , OC = 8 cm. If the square CHBN whose side length 4 cm. is cut off as shown in the figure , then the centre of gravity of the remaining part is ....

(a) (3.5 , 3)

(b) (3 , 3)

(c) (3 , 4)

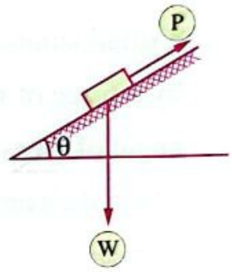
(d) (3 , 3.5)

Answer the following questions :

1 Two masses 6 kg. and 9 kg. , the distance between them is 20 m. , then the centre of gravity of the two masses at a distance .... m. from the first mass.

(a) 12 (b) 18 (c) 10 (d) 15

2 **In the opposite figure :**



A body of weight (W) newton is placed on a rough plane inclined to the horizontal with an angle of measure θ. If a force $\vec{P}$ in the direction of the line of the greatest slope of the plane upward acts on the body to make it about to move upwards the plane where the measure of the angle of friction is θ , then the magnitude of the resultant reaction force $\vec{R}$ = ... newton.

(a) W sin θ (b) W cos θ (c) W tan θ (d) W

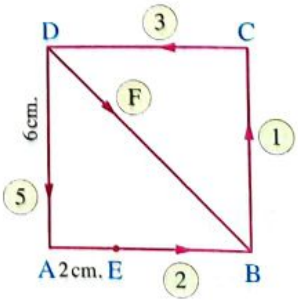
3 If the force $\overrightarrow{F_1} = (3 , -1)$ acts at the point A (1 , 2) , $\overrightarrow{F_2}$ acts at the point B (– 1 , 1) and the two forces form a couple , then the algebraic measure of the moment of the couple = ... moment unit.

(a) 5 (b) 2 (c) – 5 (d) – 2

4 Two parallel forces of magnitudes 4 , 6 newton act in two opposite directions and the distance between their lines of action is 20 cm. , then the point of action of the resultant is at distance ....

(a) 40 cm. from the first force.
(b) 40 cm. from the second force.
(c) 30 cm. from the first force.
(d) 60 cm. from the second force.

5 **In the opposite figure :**



The forces shown in the figure acts along the sides of a square ABCD with side length 6 cm. If the forces measured in newton and the resultant of these forces acts at E ∈ $\overline{AB}$ where AE = 2 cm.

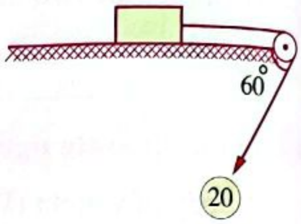
, then F = ... N.

(a) $\sqrt{2}$ (b) $2\sqrt{2}$ (c) $8\sqrt{2}$ (d) $12\sqrt{2}$

6. Two parallel forces of the same directions act at the two points A and B where AB = 40 cm. , if the magnitude of their resultant 25 gm.wt. and acts at the point $C \in \overline{AB}$ where AC = 16 cm. , then the magnitude of the smallest force = ... gm.wt.

(a) 10 (b) 20 (c) 15 (d) 5

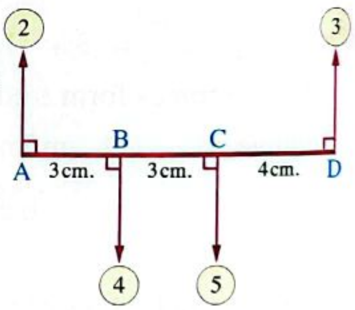
7. **In the opposite figure :**



A body of weight 80 newton is placed on a horizontal rough plane , the body is tied to the end of a light inelastic string passes over a small smooth pulley and the other end of the string is tensioned by a force of magnitude 20 newton inclined to the horizontal with angle of measure 60° downward , if the body is about to move , then the coefficient of static friction between the body and the plane = ...

(a) $\frac{1}{8}$ (b) $\frac{1}{4}$ (c) $\frac{\sqrt{3}}{8}$ (d) $\frac{1}{2}$

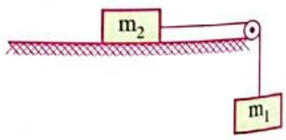
8. **In the opposite figure :**



The force of magnitudes 2 , 4 , 5 and 3 newton act at the points A , B , C and D respectively , where CD = 4 cm. , BC = AB = 3 cm. If their resultant acts at the point M where $M \in \overline{AD}$, then DM = ... cm.

(a) 3 (b) 7
(c) 4 (d) 3.5

9. **In the opposite figure :**



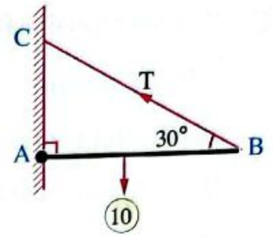
If the system is about to move when the tangent of the angle between the normal reaction and the resultant reaction is 0.2 , then $m_1 : m_2$ = ...

(a) 1 : 5 (b) 2 : 3 (c) 3 : 2 (d) 5 : 1

10. If the line of action of $\vec{F} = \hat{i} + 2\hat{j} + \hat{k}$ intersects z-axis at the point A and the component of the moment of the force $\vec{F}$ about y-axis equals 5 moment unit , then the point A is ....

(a) (0 , 0 , – 5) (b) (0 , 0 , 10) (c) (0 , 0 , 5) (d) (0 , 0 , – 10)

11 **In the opposite figure :**

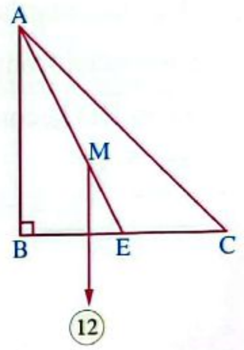


$\overline{AB}$ is a uniform rod of weight 10 kg.wt. the rod is hinged at A to a vertical wall and tied at B with a light inextensible string and inclined to the rod at an angle of measure 30° and the other end of the string fixed at C vertically above A , then the tension in the string which keeps the rod in horizontal position = ... kg.wt.

(a) 5 (b) 10 (c) 20 (d) $\frac{10}{3}$

---

12 **In the opposite figure :**

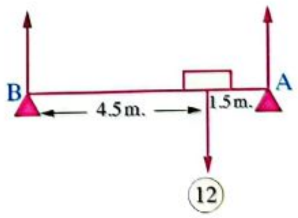


ABC is a lamina of uniform thickness and density in the form of right-angled triangle at B , BC = 30 cm. and its weight 12 newton , it can easily rotate about a small pin fixed near from the vertex A. If the lamina is in equilibrium under the action of a couple in its plane when $\overline{AB}$ is vertical , then the norm of the moment of the couple = ... newton.cm.

(a) 30 (b) 60 (c) 120 (d) 45

---

13 **In the opposite figure :**



$\overline{AB}$ is a uniform wooden board of length 6 m. and of mass 10 kg. per each metre of its length , it rests horizontally on two smooth supports at A , B. If a box of weight 12 kg.wt. is placed on it as shown in the figure , then the magnitude of the pressure on the support at B = ... kg.wt.

(a) 33 (b) 36 (c) 6 (d) 11

---

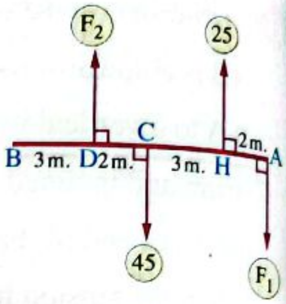
14 If a body is placed on an inclined rough plane with an angle of measure $\sin^{-1}\left(\frac{5}{13}\right)$ and it is about to move under the action of its weight , then the coefficient of static friction between the body and the plane = ...

(a) $\frac{5}{13}$ (b) $\frac{5}{12}$ (c) $\frac{12}{13}$ (d) $\frac{12}{5}$

15 **In the opposite figure :**

$\overline{AB}$ is a uniform rod of length 10 m. , and weight 45 kg.wt. a system of parallel forces act on the rod as shown in the opposite figure. If the magnitude of their resultant = 50 kg.wt. and acts vertically downward at the point M where $M \in \overline{AB}$ where AM = 0.7 m.

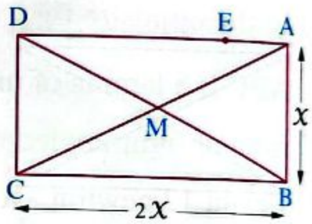
, then $F_1 : F_2 =$ ....



(a) 5 : 2 (b) 2 : 5 (c) 4 : 9 (d) 9 : 4

16 **In the opposite figure :**

A rectangular lamina its length twice its width it is freely suspended from point $E \in \overline{AD}$ and hangs in equilibrium when $\overline{BD}$ becomes horizontal , then AE = ...

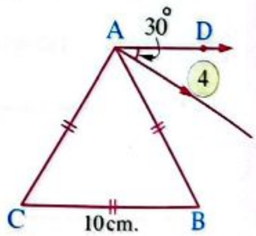


(a) $\frac{5}{4}x$ (b) $\frac{1}{4}x$

(c) $\frac{3}{8}x$ (d) $\frac{3}{4}x$

17 **In the opposite figure :**

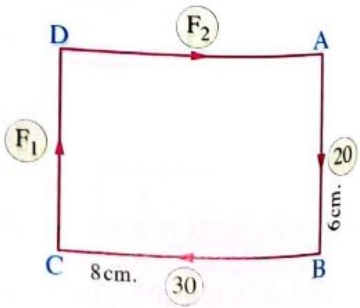
ABC is an equilateral triangle of side length 10 cm. , a force of magnitude 4 newton acts at the point A in direction makes an angle of measure 30° with $\overline{AD}$ where $\overline{AD} // \overline{BC}$, then the algebraic measure of the moment of the force about B = ... newton.cm.



(a) 20 (b) – 20 (c) 40 (d) – 40

18 **In the opposite figure :**

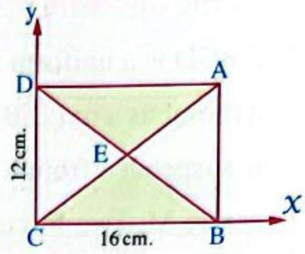
ABCD is a rectangle in which AB = 6 cm. , BC = 8 cm. the forces (measured in newton) act as shown in the figure , if a force of magnitude F newton is added to each force where F ≠ zero , the forces became completely represented by the sides of the rectangle , then the system is equivalent to a couple the algebraic measure of its moment = ... newton.cm.



(a) 480 (b) – 480 (c) 300 (d) – 300

19 In the opposite figure :

Fine lamina of uniform thickness and density in the form of rectangle ABCD , where AB = 12 cm. , BC = 16 cm. , E is the intersection point of its diagonals $\overline{AC}$, $\overline{BD}$. The triangle AED is removed and placed on Δ BEC , then the centre of gravity of the lamina in this case with respect to the point C = ...



(a) (8 , 6) (b) (8 , 4) (c) (8 , 5) (d) (6 , 2)

---

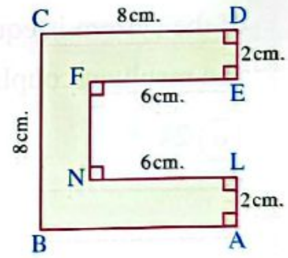
20 A force $\overrightarrow{F}$ acts at a certain point , if the moment of $\overrightarrow{F}$ about the two points B (3 , 5) and C (7 , 1) are $28\,\hat{k}$ and $-28\,\hat{k}$ respectively , then the moment of the force $\overrightarrow{F}$ vanishes about the point ....

(a) (0 , 0) (b) (5 , 3) (c) (2 , – 2) (d) (– 2 , 2)

---

21 In the opposite figure :

A lamina of uniform thickness and density , AB = BC = CD = 8 cm. , LN = EF = 6 cm. , DE = AL = 2 cm. , then distance between the centre of gravity of the lamina and each of $\overleftrightarrow{BC}$, $\overleftrightarrow{BA}$ respectively is ....



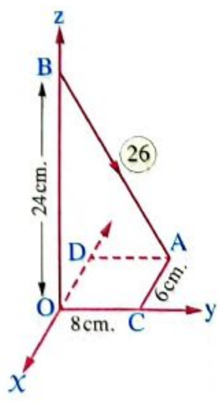
(a) 4.3 cm. , 3 cm. (b) 4 cm. , 3 cm.
(c) 3.4 cm. , 4 cm. (d) 3 cm. , 4 cm.

---

22 In the opposite figure :

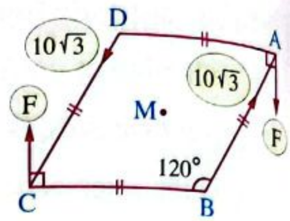
B ∈ z-axis , BO = 24 cm. , D ∈ x-axis , C ∈ y-axis , ACOD is a rectangle where AC = 6 cm. , CO = 8 cm.

A force $\overrightarrow{F}$ of magnitude 26 newton acts in the direction $\overrightarrow{BA}$, then $\overrightarrow{M}_o$ = ...



(a) $-192\,\hat{i} + 144\,\hat{j}$ (b) $192\,\hat{i} - 144\,\hat{j}$
(c) $-192\,\hat{i} - 144\,\hat{j}$ (d) $144\,\hat{i} - 192\,\hat{j}$

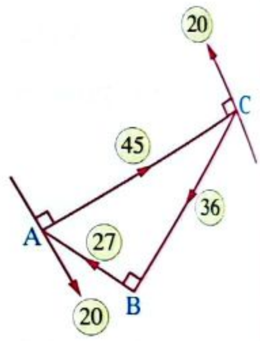
23 In the opposite figure :



ABCD is a uniform fine lamina in form of a rhombus , m (∠ B) = 120° , the lamina is suspended from a small hole near to its centre M. Two forces $10\sqrt{3}$ N. and $10\sqrt{3}$ N. acts in $\overrightarrow{BA}$, $\overrightarrow{DC}$ respectively and two forces of magnitudes F , F newton act at A and C perpendicular to $\overline{AD}$, $\overline{BC}$ respectively as shown in the figure. If the lamina is in equilibrium , then F = ... N.

(a) 5 (b) $5\sqrt{3}$ (c) $10\sqrt{3}$ (d) 10

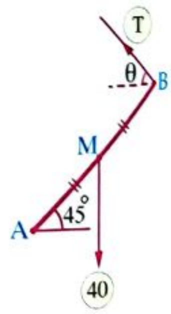
24 In the opposite figure :



ABC is a right-angled triangle at B in which AB = 9 cm. , BC = 12 cm. , forces of magnitudes 27 , 45 and 36 newton act in $\overrightarrow{BA}$, $\overrightarrow{AC}$, $\overrightarrow{CB}$ respectively and the forces 20 , 20 newton act at A , C in directions perpendicular to $\overline{AC}$ as shown in the figure. If the system is equivalent to a couple , then the norm of moment of the resultant couple = ... newton.cm.

(a) 24 (b) 624 (c) 48 (d) 948

25 In the opposite figure :



$\overline{AB}$ is a uniform rod of weight 40 kg.wt. its end A is attached to a fixed hinge and its end B is pulled by a light inelastic string inclined to the horizontal by an acute angle of measure θ , the rod equilibrated when it makes an angle of measure 45° with the horizontal. If the magnitude of the reaction of the hinge in equilibrium position = $10\sqrt{10}$ kg.wt. , then the reaction of the hinge inclined to the horizontal by angle of tangent = ...

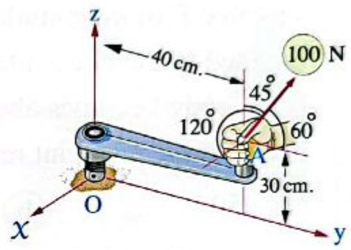
(a) $\frac{1}{3}$ (b) 3 (c) $\frac{1}{2}$ (d) 1

Answer the following questions :

1. $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces act in opposite directions and the line of action of their resultant far from the line of action of the first force 9 cm. and from the second 12 cm. If the magnitude of their resultant is 14 N. , then $F_1 + F_2 =$ .... N.

(a) 14 (b) 49 (c) 98 (d) 104

2. **In the opposite figure :**



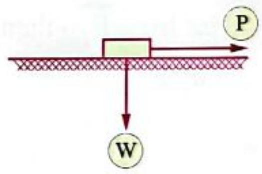
The norm of the moment of the force 100 N.about the x-axis

$\simeq$ .... newton.cm.

(a) 1282.43 (b) 1328.43

(c) 1420.5 (d) 1428.4

3. **In the opposite figure :**



A body of weight (W) newton placed on a rough horizontal plane. A horizontal force of magnitude P newton acts on the body trying to move it. If the resultant reaction in newton $\in]6 , 12]$, then the measure of the angle of friction is ....°

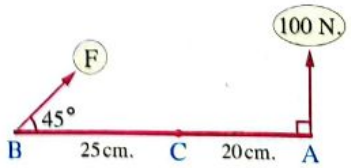
(a) 15 (b) 30 (c) 60 (d) 45

4. If A , B and C are not collinear points and a set of forces lie on their plane where $\overrightarrow{M_A} = \overrightarrow{M_B} = \overrightarrow{M_C} = \vec{0}$, then ....

(a) the set of forces is in equilibrium. (b) the set of forces is equivalent to a couple.

(c) the forces are parallel. (d) the forces intersect at one point.

5. **In the opposite figure :**



If the magnitude of the sum of moments of the two forces 100 , F N. about C equals 1000 N.cm. , then F = ... N.

(a) 20 or 40 (b) 40 or 120

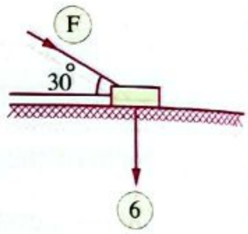
(c) $20\sqrt{2}$ or $40\sqrt{2}$ (d) $40\sqrt{2}$, $120\sqrt{2}$

6. Two bodies , their weights are 2 W , 3 W connected by light string coincides with the line of greatest slope of an inclined rough plane the coefficients of static frictions between them and the plane are $\frac{1}{4}$ and $\frac{1}{6}$ respectively , if θ is the measure of the angle between the plane and the horizontal plane is increased gradually till the string between them taut and the two bodies were about to slide , then tan θ = ...

(a) $\frac{1}{4}$ (b) $\frac{1}{5}$ (c) $\frac{3}{7}$ (d) 1

7. **In the opposite figure :**

A body of weight 6 newton is placed on a rough horizontal plane , a force $\vec{F}$ of magnitude 6 newton acts on the body in a direction inclined to the horizontal by an angle of measure 30° downwards , if the body becomes about to move , then the measure of the angle between the resultant reaction $\vec{R}$ and the force $\vec{F}$ equals .... °



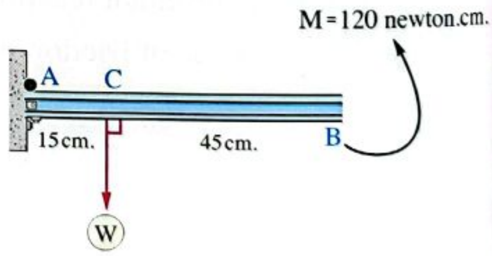
(a) 150 (b) 130 (c) 60 (d) 30

8. $\vec{F}_1$ and $\vec{F}_2$ are two parallel forces where $3\vec{F}_1 = 2\vec{F}_2$ and their resultant at a distance 15 cm. far from $\vec{F}_1$, then the distance between the line of action of the resultant and $\vec{F}_2$ = ... cm.

(a) 8 (b) 10 (c) 12 (d) 25

9. **In the opposite figure :**

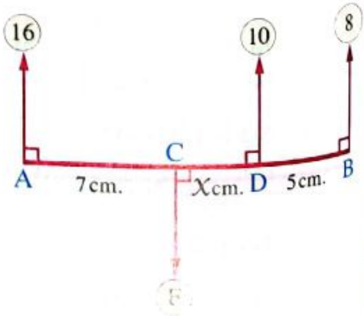
$\overline{AB}$ is a non uniform rod of length 60 cm. and of weight (W) acts at point C , it is hinged at A with hinge fixed on a vertical wall. A couple of moment 120 newton. cm. acts on the rod in its plane. The rod becomes in equilibrium on horizontal position. If the reaction at the hinge at A is R , then W + R = ... newton.



(a) 16 (b) 60 (c) 30 (d) 18

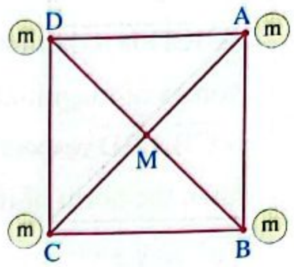
10. **In the opposite figure :**

$\overline{AB}$ is a light rod of negligible weight is in equilibrium position horizontally under the action of the forces shown on the figure , where the forces are measured in newton , then X = ... cm.



(a) 8 (b) 5
(c) 7 (d) 4

11 The opposite figure represents a system of 4 equal masses placed at the vertices of a square , if the mass at B has been moved in $\overrightarrow{BM}$ direction then the centre of gravity of the system ....



(a) remains fixed at M

(b) moves in $\overrightarrow{MB}$ direction.

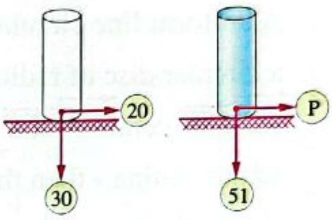
(c) moves in $\overrightarrow{MD}$ direction.

(d) moves in $\overrightarrow{MA}$ direction.

---

12 **In the opposite figure :**

An empty container of weight 30 N. is placed on a rough horizontal plane. The horizontal force that makes the container about to move is 20 N. liquid is poured into the container till its weight becomes 51N. , then the horizontal force P can make it about to move = ... N.



(a) 20 (b) 34 (c) 41 (d) 76.5

---

13 Force $\overrightarrow{F}$ of magnitude 90 N. acts along $\overrightarrow{AB}$ where A (11 , 0 , 4) , B (7 , 7 , 0) , then the moment of the force $\overrightarrow{F}$ about C (0 , 6 , 5) equals ....

(a) $170\,\hat{i} - 400\,\hat{j} + 530\,\hat{k}$ (b) $310\,\hat{i} - 480\,\hat{j} + 530\,\hat{k}$

(c) $310\,\hat{i} + 480\,\hat{j} + 530\,\hat{k}$ (d) $170\,\hat{i} + 400\,\hat{j} + 1010\,\hat{k}$

---

14 $\overline{AB}$ is a non uniform rod of weight 12 N. The rod rests horizontally on a smooth peg at point C where AC = 6 cm. , BC = 3 cm. If the rod rests horizontally on two supports one at A and the other at B ; then the reaction at A and B respectively are .... N.

(a) 6 , 6 (b) 3 , 9 (c) 8 , 4 (d) 4 , 8

---

15 ABC , ABD are two laminas each in the form of an isoscele triangle of common base $\overline{AB}$ and on different sides of it , their heights corresponding to this base are 12 cm. , 6 cm. respectively, then the centre of gravity of the system distant from $\overline{AB}$ = ... cm.

(a) $\frac{1}{2}$ (b) 1 (c) 1.5 (d) 2

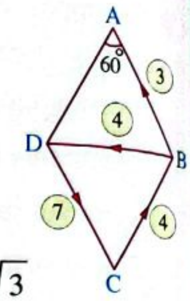
---

16 If $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces where $\overrightarrow{F_1} = 3\,\hat{i} - 4\,\hat{j}$, $\overrightarrow{F_2} = -6\,\hat{i} + 8\,\hat{j}$. They are acting at A (1 , 0) , B (6 , 0) respectively , then the point of intersection of their resultant with $\overleftrightarrow{AB}$ is ....

(a) (8 , 0) (b) (9 , 0) (c) (0 , 0) (d) (11 , 0)

17 **In the opposite figure :**

ABCD is a rhombus of side length 6 cm. , m (∠ A) = 60° , the forces of magnitudes 3 , 7 , 4 and 4 newton act along $\overrightarrow{BA}$, $\overrightarrow{DC}$, $\overrightarrow{CB}$, $\overrightarrow{BD}$ respectively , if the system is equivalent to a couple , then the norm of its moment = ... newton.cm.

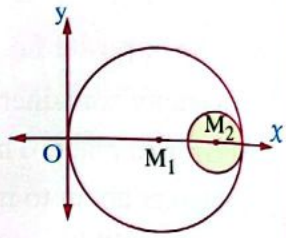


(a) $10\sqrt{3}$ (b) $15\sqrt{3}$ (c) $25\sqrt{3}$ (d) $21\sqrt{3}$

---

18 **In the opposite figure :**

A uniform fine circular lamina of radius length 30 cm. a circular disc of radius length 10 cm. is removed , and its centre is at a distance 20 cm. from the centre of the lamina , then the centre of gravity of the remaining part is at a distance .... cm. from the centre of gravity of the origianl lamina.

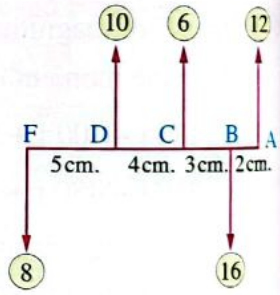


(a) 1.5 (b) 2 (c) 2.5 (d) 3

---

19 **In the opposite figure :**

$\overline{AF}$ is a light rod. Parallel forces act on it as shown in the figure and the line of action of their resultant intersect $\overleftrightarrow{AF}$ at point E , then ....



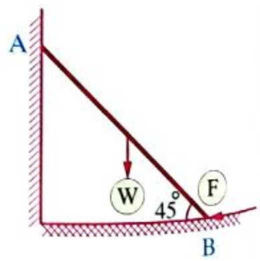
(a) $E \in \overline{AC}$ (b) $E \in \overline{CF}$

(c) $E \in \overrightarrow{FA}$, $E \notin \overline{FA}$ (d) $E \in \overrightarrow{AF}$, $E \notin \overline{AF}$

---

20 **In the opposite figure :**

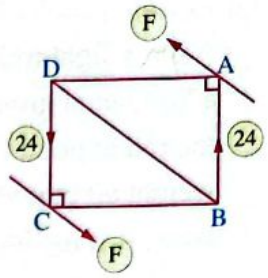
$\overline{AB}$ is a uniform rod of weight (W) rests with its ends A against a smooth vertical wall and its end B on a rough horizontal ground , the coefficient of static friction between them is $\frac{3}{4}$. If a horizontal force acted on the rod at the point B to make it about to move towards the wall when the rod inclined to the horizontal by an angle of measure 45° , then the magnitude of the horizontal force = ...



(a) $\frac{1}{4}$ W (b) $\frac{5}{4}$ W (c) $\frac{3}{4}$ W (d) $\frac{7}{4}$ W

21 **In the opposite figure :**

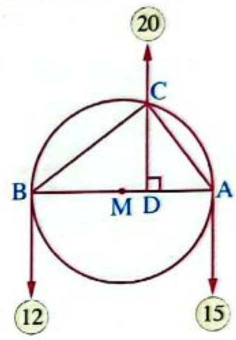
ABCD is a rectangle in which AB = 6 cm. , BC = 8 cm. , the two forces of magnitudes F , F newton act at the two points A and C and parallel to $\overleftrightarrow{BD}$ to form a couple (as the figure shown) , if another two forces of magnitudes 24 , 24 newton act along $\overrightarrow{BA}$ and $\overrightarrow{DC}$ to form a couple equivalent to the first couple , then F = ... newton.



(a) 14.4 (b) 20 (c) 25 (d) 19.2

22 **In the opposite figure :**

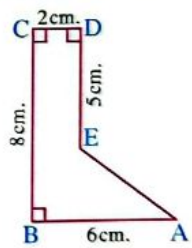
The coplanar parallel forces 20 , 15 , 12 newton act at the points C , A , B respectively in directions perpendicular to the diameter $\overline{AB}$ in the circle M , if AC = 6 cm. , CB = 8 cm. , then the sum of the algebraic measure of the moments of these forces about the centre of the circle (M) equals .... newton.cm.



(a) – 13 (b) 43
(c) 13 (d) – 43

23 **In the opposite figure :**

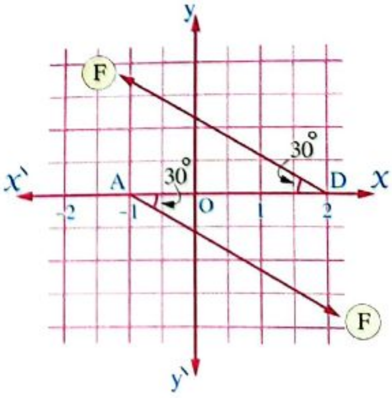
ABCDE is a fine lamina of a uniform thickness and density , where AB = 6 cm. , BC = 8 cm. , CD = 2 cm. and DE = 5 cm. , then the centre of gravity of the lamina with respect to $\overrightarrow{BC}$, $\overrightarrow{BA}$ respectively is ....



(a) $\left(\frac{18}{11} , \frac{35}{11}\right)$ (b) $\left(\frac{73}{22} , \frac{20}{11}\right)$ (c) $\left(\frac{48}{11} , \frac{35}{11}\right)$ (d) $\left(\frac{20}{11} , \frac{73}{22}\right)$

24 **In the opposite figure :**

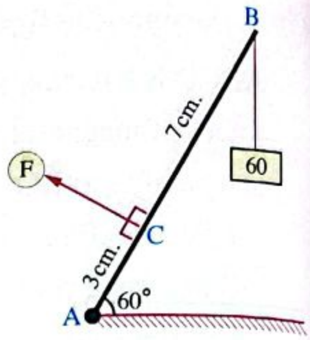
Forces $\overrightarrow{F_1} = 2\hat{i} - 4\hat{j}$, $\overrightarrow{F_2} = 3\hat{i} - 5\hat{j}$, $\overrightarrow{F_3} = -5\hat{i} + 9\hat{j}$, act at the points A (– 1 , 0) , B (0 , 2) , C (1 , – 2) and they form a couple. Also two forces of magnitudes F , F act at the two points A and D as shown in the figure if the whole system is in equilibrium (given the magnitudes of the forces are given in gm.wt. and act in a rigid body lies in the x y-plane) , then F = ... gm.wt.



(a) $\sqrt{3}$ (b) 3 (c) 2 (d) $\sqrt{2}$

25 In the opposite figure :

$\overline{AB}$ is a light rod connected at A with a hinge fixed to a horizontal ground. Force F acts on the rod perpendicular to the rod at point C where CA = 3 cm. , CB = 7 cm. A body of weight 60 gm.wt. hanged at B and the rod kept in equilibrium when it is inclined to the horizontal at an angle of measure 60° , then the reaction of the hinge at A = ... gm.wt.



ⓐ $15\sqrt{19}$ ⓑ $10\sqrt{19}$

ⓒ $20\sqrt{19}$ ⓓ $25\sqrt{19}$

Practice Exams

Exam 5

Answer the following questions :

1. F_1 , F_2 are two forces , the magnitude of the first is 4 kg.wt. and the magnitude of their resultant R equals 6 kg.wt. , the distance between F_1 and R equals 8 cm. If F_1 and R act in two opposite directions , then the distance between F_1 and F_2 equals .... cm.

(a) 3.2 (b) 4.8 (c) 9.6 (d) 12.6

---

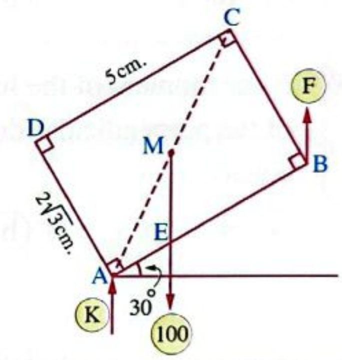
2. A body of weight 3 newton is placed on a horizontal rough plane whose friction coefficient with the body is $\frac{1}{3}$, a horizontal force acted on it , trying to move it , then the magnitude of the friction force $\in$ ....

(a) $[\frac{1}{3}, 3]$ (b) $[1, \infty[$ (c) $]0, 1]$ (d) $[0, \frac{1}{3}]$

---

3. **In the opposite figure :**

If the lamina ABCD is in equilibrium under action of the shown forces , then K – F = ... force unit.



(a) 40 (b) 50
(c) 60 (d) 70

---

4. A regular thin lamina in the shape of an equilateral triangle ABC is suspended by a string from a point on one of its edges (such that $\overline{AC}$) to divide it by the ratio 1 : 2 from C , then the measure of the angle of inclination of this edge to the vertical equals ....

(a) 22.5° (b) 30° (c) 45° (d) 60°

---

5. From the following sets of forces , there are two parallel forces act at two opposite directions , then they are ....

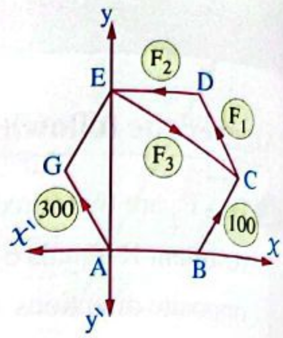
(a) $\overrightarrow{F_1} = 2\hat{i} - 3\hat{j}$, $\overrightarrow{F_2} = 4\hat{i} - 6\hat{j}$
(b) $\overrightarrow{F_1} = 2\hat{i} - 3\hat{j}$, $\overrightarrow{F_2} = -4\hat{i} + 6\hat{j}$
(c) $\overrightarrow{F_1} = 2\hat{i} - 3\hat{j}$, $\overrightarrow{F_2} = 6\hat{i} - 4\hat{j}$
(d) $\overrightarrow{F_1} = 2\hat{i} - 3\hat{j}$, $\overrightarrow{F_2} = -6\hat{i} + 4\hat{j}$

---

6. Two forces $\overrightarrow{F_1} = (2, -5)$, $\overrightarrow{F_2}$ act at the two points A $(2, \ell)$, B $(\ell, 3)$ respectively. If the two forces form a couple its moment is $-7\hat{k}$, then ℓ = ...

(a) – 1 (b) zero (c) 1 (d) 2

7 **In the opposite figure :**

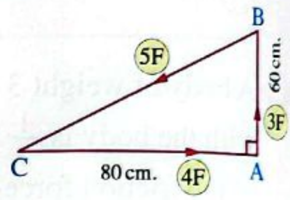


ABCDEG is a uniform hexagon with side length 40 cm.
If the given forces are in equilibrium
, then F_2 = ... newton.

(a) 600 (b) $300\sqrt{3}$
(c) 100 (d) 150

---

8 **In the opposite figure :**



ABC is a right-angled triangle at A , in which : AB = 60 cm. and AC = 80 cm. If forces of magnitudes : 3 F , 5 F and 4 F newton act along $\overrightarrow{AB}$, $\overrightarrow{BC}$ and $\overrightarrow{CA}$ respectively , then the moment of the equivalent couple equals .... newton.cm.

(a) 480 F (b) 240 F (c) 120 F (d) $\frac{96000}{F}$

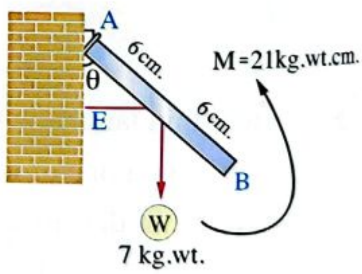
---

9 If the moment of the force $\vec{F} = 3\,\hat{i} - \hat{j}$ about a point is $21\,\hat{j} + 7\,\hat{k}$, then the length of the perpendicular drawn from this point to the line of action of the force in length unit equals ....

(a) $\frac{1}{7}$ (b) $\frac{1}{7}\sqrt{10}$ (c) 7 (d) $10\sqrt{7}$

---

10 **In the opposite figure :**



$\overline{AB}$ is a uniform rod of weight 7 kg.wt. hinged at A to a vertical wall and kept in equilibrium by a couple its moment 21 kg.wt. cm., then θ = ...

(a) 15° (b) 30°
(c) 45° (d) 60°

---

11 The two forces $\overrightarrow{F_1} = 3\,\hat{i} - \hat{j}$, $\overrightarrow{F_2} = -9\,\hat{i} + 3\,\hat{j}$ act at the two points A (– 1 , 0) , B (1 , 2) respectively , then the point of intersection of the line of action of the resultant of the two forces with $\overleftrightarrow{AB}$ ....

(a) (2 , 3) (b) (– 6 , 2) (c) (3 , 1) (d) (2 , 5)

---

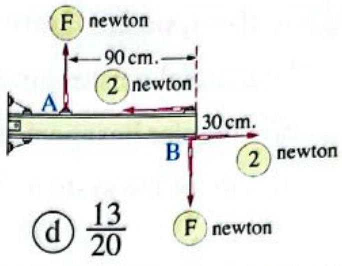
12 If m_1 , m_2 are two masses act at A and B where AB = 12 cm. and their centre of gravity at a distance 4 cm. from B , then the centre of gravity of the two masses 2 m_1 , m_2 which act at A and B also lies at a distance .... cm. from B

(a) 2 (b) 14 (c) 6 (d) 8

13 **In the opposite figure :**

If the moment of the resultant couple = – 1.5 N.m.

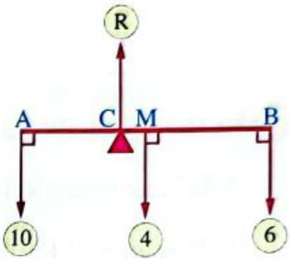
, then F = ... N.



(a) $\frac{7}{3}$ (b) $\frac{41}{60}$ (c) $\frac{2}{3}$ (d) $\frac{13}{20}$

14 **In the opposite figure :**

$\overline{AB}$ is a uniform rod of length 100 cm. and of weight 4 kg.wt. rests on a smooth support at the point C and a system of parallel forces act on it as shown in the figure (measured in kg.wt.) , if the rod equilibrated horizontally , then MC = ... cm.



(a) 30 (b) 40 (c) 50 (d) 10

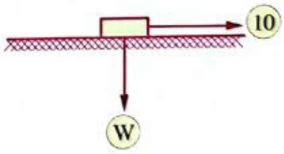
15 If a body of weight (W) is placed on a rough plane inclined to the horizontal at an angle of measure θ and P_1 , P_2 are the greatest and the smallest forces acting in direction of the line of greatest slope of the plane up and keep the body in equilibrium , F_s is the limiting static friction , then $P_1 + P_2$ = ...

(a) 2 W sin θ (b) W sin θ (c) 2 W cos θ (d) $2 \mu_s R$

16 **In the opposite figure :**

A body of weight (W) kg.wt. is placed on a rough horizontal surface. A horizontal force of magnitude 10 kg.wt. acts on the body and makes the body about to move.

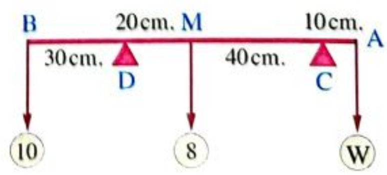
The resultant reaction of the surface is $10\sqrt{2}$ kg.wt. , then the weight of the body (W) = ... kg.wt.



(a) 10 (b) 20 (c) $10\sqrt{2}$ (d) $20\sqrt{2}$

17 **In the opposite figure :**

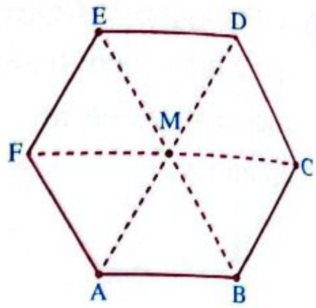
$\overline{AB}$ is a uniform rod of weight 8 N. If a 10 N. weight is fixed at B , then the weight should be hanged at A to make the rod in equilibrium horizontally ∈ .... N.



(a) [3 , 124] (b) {2 , 122} (c) [2 , 122] (d) [1 , 62]

18 **In the opposite figure :**

Four equal masses are fixed at the vertices A , B , C and E of a regular hexagon its centre is M if N is the centre of gravity of the system , then NB : NE = ...



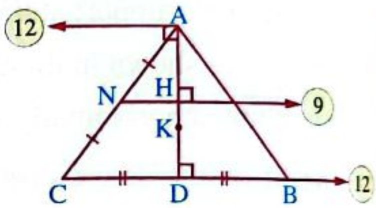
(a) 1 : 3 (b) 1 : 4

(c) 3 : 5 (d) 3 : 8

---

19 **In the opposite figure :**

ABC is a triangle in which AB = AC = 15 cm. , BC = 18 cm. , the coplanar parallel forces 12 , 9 , 12 newton act at the points A , N , C respectively and perpendicular to $\overline{AD}$, if k is the point of intersection of the medians of triangle ABC , then the sum of the algebraic measures of moments of these forces about the point k = ... newton.cm.

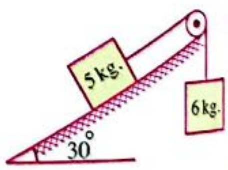


(a) – 126 (b) 162 (c) – 162 (d) 126

---

20 **In the opposite figure :**

A 5 kg. body is placed on a rough inclined plane , connected with light string passes over a smooth. Pulley at the edge of the plane and the other end of the string tied to a body of mass 6 kg. If the system is in equilibrium , then the magnitude and the direction of the friction force is ....

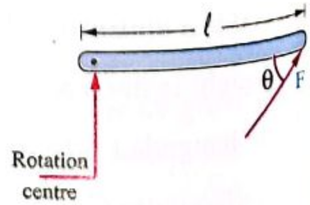


(a) 3.5 kg.wt. upward. (b) 3.5 kg.wt. downward.

(c) 8.5 kg.wt. upward. (d) 8.5 kg.wt. downward.

---

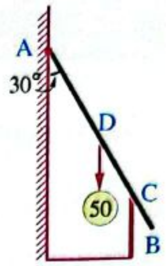
21 A rod of length ℓ. It can rotate easily about a point at one of its ends. A force of a magnitude F acts on the other end and inclines on the rod with an angle of measure θ if $\overrightarrow{F}$ should be perpendicular to the rod , at which distance from the rotation centre can F affect such that it has the same moment ....



(a) $\ell \sin \theta$ (b) $\ell \cos \theta$ (c) ℓ (d) $\ell \tan \theta$

22 **In the opposite figure :**

$\overline{AB}$ is a uniform rod of length 30 cm. and weight 50 gm.wt. It is hinged at A to a vertical wall and one of its points C , 5 cm. from B , rests on a smooth vertical barrier , the rod rests when it makes an angle of measure 30° to the vertical , then the reaction of the barrier equals .... gm.wt.



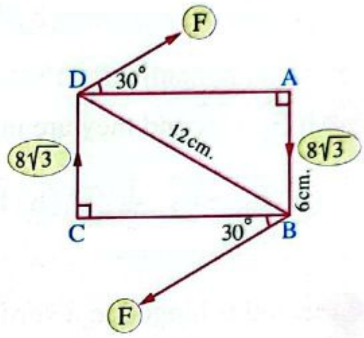
(a) $25\sqrt{3}$ (b) 25 (c) $15\sqrt{3}$ (d) 15

---

23 **In the opposite figure :**

ABCD is a rectangle in which AB = 6 cm. and BD = 12 cm. , the shown forces act on it , if the couple formed from the two forces $8\sqrt{3}$, $8\sqrt{3}$ gm.wt. is equivalent to the couple formed from the two forces F , F gm.wt.

, then F = ... gm.wt.



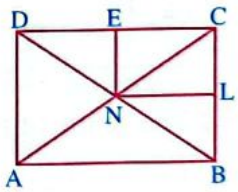
(a) 8 (b) $4\sqrt{3}$

(c) 4 (d) $8\sqrt{3}$

---

24 **In the opposite figure :**

ABCD is a lamina of a uniform thickness and density in the form of a rectangle in which AB = 12 cm. , BC = 8 cm. If L , E are the midpoints of $\overline{BC}$, $\overline{CD}$ respectively , $\overline{AC} \cap \overline{BD} = \{N\}$



The rectangle NLCE is cut off from the lamina.

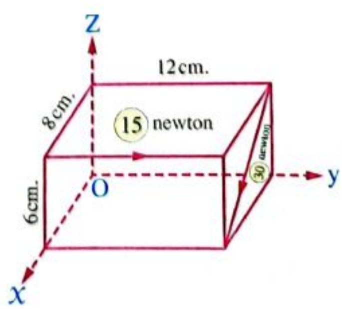
If the lamina is suspended freely from A , then the tangent of the inclination angle of $\overline{AB}$ to the vertical in the equilibrium position = ...

(a) $\frac{2}{3}$ (b) $\frac{3}{4}$ (c) $\frac{4}{5}$ (d) $\frac{5}{6}$

---

25 **In the opposite figure :**

The sum of moments of the forces about O = ...



(a) $-306\,\hat{i} + 144\,\hat{j} + 168\,\hat{k}$

(b) $-306\,\hat{i} - 144\,\hat{j} - 168\,\hat{k}$

(c) $-216\,\hat{i} + 144\,\hat{j} - 288\,\hat{k}$

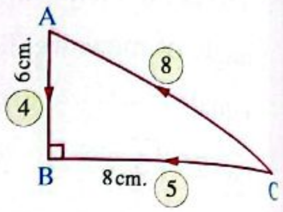
(d) $-306\,\hat{i} + 144\,\hat{j} - 168\,\hat{k}$

Practice Exams

Exam 6

Answer the following questions :

1 In the opposite figure :



Δ ABC is right-angled at B , forces of magnitudes 8 , 4 and 5 newton act along $\overrightarrow{CA}$, $\overrightarrow{AB}$ and $\overrightarrow{CB}$, then the norm of the sum of moments of the forces about A = ... newton.cm.

(a) 30 (b) 32 (c) 38.4 (d) zero

---

2 If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$ and they are in opposite directions , then $\overrightarrow{R}$ = ...

(a) $\overrightarrow{F_1} - \overrightarrow{F_2}$ (b) $\overrightarrow{F_1} + \overrightarrow{F_2}$ (c) $\overrightarrow{F_1} \times \overrightarrow{F_2}$ (d) $\overrightarrow{F_1} \cdot \overrightarrow{F_2}$

---

3 A rod is hinged to a vertical wall , X_1 , Y_1 are the algebraic components to the reaction of the hinge and if X_1 = 3 newton , Y_1 = 4 newton , then the reaction of the hinge equals .... newton.

(a) 1 (b) 5 (c) 7 (d) 12

---

4 The centre of gravity of a system made up of two masses 6 kg. and 9 kg. and the distance between them is 10 m. is distant .... m. from the first mass.

(a) 3 (b) 4 (c) 5 (d) 6

---

5 If $\overrightarrow{F} = 2\,\hat{i} + \ell\,\hat{j} - \hat{k}$ acts at the point A (4 , – 2 , 0) and the moment of $\overrightarrow{F}$ about the origin point is equal to $2\,\hat{i} + 4\,\hat{j} + 16\,\hat{k}$, then ℓ = ...

(a) 2 (b) 3 (c) 4 (d) 5

---

6 A light scaled ruler is suspended horizontally by two vertical strings , one of them is at a scale 10 and the other at the scale 70 , a weight 12 kg.wt. is suspended at the scale 25 , then the tension in the string closest to the weight = ... kg.wt.

(a) 9 (b) 3 (c) 12 (d) 6

7. $\overline{AB}$ is a uniform ladder of length 8 metres and of weight 20 kg.wt. rests at its end A on a rough horizontal ground and rests at one of its points C on the edge of a smooth fence of height 4 metres above the ground. If the ladder is about to slide when it inclines to the horizon with an angle of tangent $\frac{4}{3}$, then the coefficient of static friction between the ladder and the ground = ...

(a) $\frac{1}{2}$ (b) $\frac{1}{48}$ (c) $\frac{4}{5}$ (d) $\frac{48}{89}$

8. A uniform square lamina of weight 40 gm.wt. is suspended freely from the vertex A and a weight of 10 gm.wt. is fixed at the vertex B , then the tangent of the inclination angle of the diagonal $\overline{AC}$ to the vertical in the equilibrium position = ...

(a) $\frac{1}{6}$ (b) $\frac{1}{5}$ (c) $\frac{1}{4}$ (d) $\frac{1}{2}$

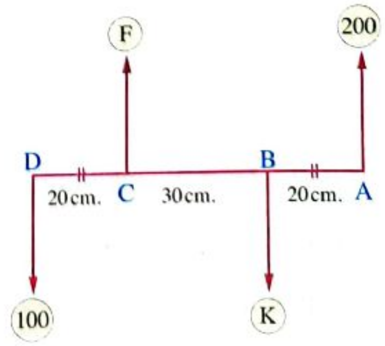
9. If $\vec{F} = \ell \hat{i} + m \hat{j}$ act at the point A (4 , 2) and the moment vector of $\vec{F}$ about the origin point is $-22 \hat{k}$ and about the point B (13 , 1) is $22 \hat{k}$, then $\ell + m$ = ...

(a) 8 (b) 2 (c) -2 (d) -8

10. Two parallel forces are in opposite directions , their magnitudes 5 and 8 newton , the distance between their line of actions 24 cm. , then the distance between the line of action of the resultant and the second force = ... cm.

(a) 20 (b) 40 (c) 60 (d) 80

11. The opposite figure shows the parallel forces measured by newton act on a rod $\overline{AD}$, if the magnitude of the resultant is 300 newton and it acts upwards at 40 cm. from A and lies between A and D , then F + K = ... newton.



(a) 800 (b) 300 (c) 500 (d) 100

12 ABCD is a square of side length 16 cm. Forces of magnitudes 40 , F , 40 , F gm.wt. act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{DA}$ respectively. If these four forces are equivalent to a couple the norm of its moment equals 480 gm.wt.cm. in the cyclic direction ADCB , then F = ... gm.wt.

(a) 16 (b) 640 (c) 5 (d) 10

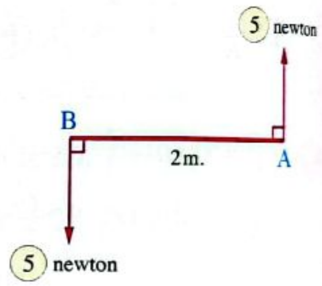
---

13 A boy pushes a stone of weight 56 newton by a horizontal force of magnitude 42 newton on a horizontal road , the stone was about to move , then the coefficient of static friction between the stone and the road = ...

(a) $\frac{2}{3}$ (b) $\frac{1}{2}$ (c) $\frac{3}{4}$ (d) 42

---

14 The algebraic measure of the moment of the couple of the forces shown in the opposite figure measured by newton. m. equals ....

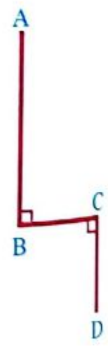


(a) – 50 (b) – 10

(c) 10 (d) 50

---

15 **In the opposite figure :**



ABCD is a wire of length 32 cm.

in which AB = 2 BC = 2 CD = 16 cm.

, then the distance between the centre of gravity of the wire and both $\overleftrightarrow{BC}$ and $\overleftrightarrow{BA}$ respectively = ...

(a) 3 cm. , 3 cm. (b) 4 cm. , 4 cm.

(c) 3 cm. , 5 cm. (d) 4 cm. , 8 cm.

---

16 ABCD is a parallelogram , in which AB = 18 cm. , BC = 20 cm. , m (∠ A) = 30° forces of magnitudes 8 , 6 , 8 , 6 newton act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$ and $\overrightarrow{DA}$ respectively. , then the two forces of magnitude F , F newton act at A and D and are perpendicular to $\overline{AD}$ and equivalent to the previous set of forces , then F = ... newton.

(a) 1.3 (b) 2.6 (c) 2.7 (d) 6.7

17 If $\vec{F} = \hat{i} - 2\hat{j}$ acts at a point A (2 , 3) , then the length of the perpendicular drawn from B (2 , 1) to the line of action of the force $\vec{F}$ = ... length unit.

(a) $\frac{2\sqrt{5}}{5}$ (b) $\sqrt{5}$ (c) 2 (d) $\frac{\sqrt{5}}{5}$

18 A body of weight 30 newton is placed on a rough inclined plane. When the plane is inclined at 30° to the horizontal , the body is about to slide down.

If the inclination of the plane to the horizontal is increased to be 60° , then magnitude of the force act on the body and is parallel to the line of greatest slope to make the body about to move upwards = ... newton.

(a) $10\sqrt{3}$ (b) $15\sqrt{3}$ (c) $20\sqrt{3}$ (d) $45\sqrt{3}$

19 The coefficient of static friction is ....

(a) a force acts against the force acting on the body.

(b) the resultant of the normal reaction and friction.

(c) the ratio between the magnitude of the limiting friction to the magnitude of the normal reaction.

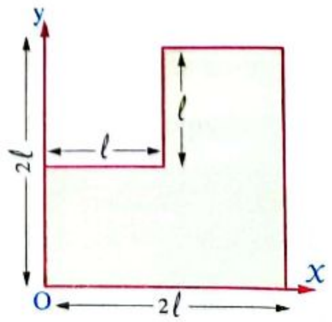
(d) the ratio between the magnitude of the resultant reaction to the magnitude of the limiting friction.

20 If the magnitudes of two parallel forces acting in the same direction are $\frac{x}{y}$, $\frac{y}{x}$ N. and their resultant 2 N. , then ....

(a) $x = y$ (b) $x = 2y$ (c) $y = 2x$ (d) $x = \frac{1}{4}y$

21 **In the opposite figure :**

A fine lamina of uniform thickness and density , then its centre of gravity ....

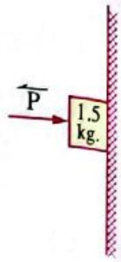


(a) $(\frac{5}{6}\ell , \frac{5}{6}\ell)$ (b) (ℓ , ℓ)

(c) $(\frac{7}{6}\ell , \frac{5}{6}\ell)$ (d) $(\frac{3}{2}\ell , \ell)$

22 **In the opposite figure :**

The least horizontal force $\overrightarrow{P}$ required to keep a body of mass 15 kg. in equilibrium on a rough vertical wall if the coefficient of static friction between the body and the wall equals $\frac{1}{5}$ is .... kg.wt.



(a) 5 (b) 25 (c) 3 (d) 75

---

23 In which of the following the centre of gravity is not the same as the point of intersection of its medians ?

(a) A uniform density lamina in form of an equilateral triangle.

(b) A uniform density lamina in form of a scalene triangle.

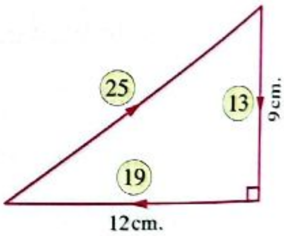
(c) A uniform density thin wire in form of an equilateral triangle.

(d) A uniform density thin wire in form of a scalene triangle.

---

24 **In the opposite figure :**

If the given forces are given in newton, then the force (F) that should be added to each force from the given forces to make the system equivalent to a couple equals .... N.



(a) 2 (b) 3 (c) 4 (d) 5

---

25 If $\overrightarrow{F}$ is a force acting in the plane of ΔABC, $D \in \overline{BC}$ where $\frac{BD}{DC} = \frac{1}{5}$ and $M_B = 10$ N.cm., $M_D = 6$ N.cm., then $M_C =$ .... N.cm.

(a) 16 (b) 14 (c) -14 (d) -40

Practice Exams

Exam 7

Answer the following questions :

1. A body of weight 3 newton is placed on a horizontal rough plane whose friction coefficient with the body is $\frac{1}{3}$, a horizontal force acted on it , trying to move it , then the friction force $\in$ ....

   (a) $\left[\frac{1}{3}, 3\right]$　(b) $[1, \infty[$　(c) $]0, 1]$　(d) $\left[0, \frac{1}{3}\right]$

2. The centre of gravity of the following system $m_1 = 1$ at $(0, 0)$, $m_2 = 1$ at $(3, 0)$, $m_3 = 2$ at $(3, 4)$ is ....

   (a) $\left(\frac{9}{4}, 0\right)$　(b) $\left(\frac{9}{4}, 2\right)$

   (c) $\left(2, \frac{9}{4}\right)$　(d) $(9, 8)$

3. Two forces form a couple , the magnitude of one of the two forces is 13 newton and the moment of the couple is 65 newton.cm. , then the perpendicular distance between them equals .... cm.

   (a) 5　(b) 52　(c) 78　(d) 845

4. $\overline{AD}$ is a non-uniform rod rests on two supports at B and C where AB = BC = CD , it is found that the rod is about to rotate about B if a weight 5 kg.wt. is suspended at A and the rod is about to rotate about C if a weight 10 kg.wt. is suspended at D , then the weight of the rod = ... kg.wt.

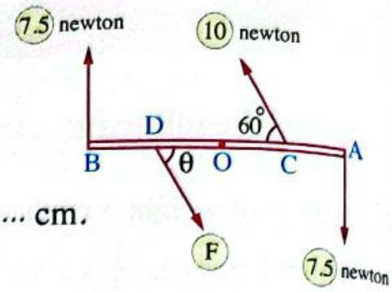
   (a) 15　(b) 30　(c) 5　(d) 3

5. ABCD is a square with side length 10 cm. , a force of magnitude 20 newton acts along $\overrightarrow{AB}$, then the norm of the moment of this force about the centre of the square equals .... newton.cm.

   (a) $50\sqrt{2}$　(b) 100

   (c) $100\sqrt{2}$　(d) 200

6 **In the opposite figure :**



If $\overline{AB}$ is a light horizontal rod of negligible weight and its length is 30 cm. , O is the midpoint of $\overline{AB}$, then the length of $\overline{CD}$ in case of equilibrium equals .... cm.

(a) 10 (b) 15
(c) $10\sqrt{3}$ (d) $15\sqrt{3}$

---

7 When a weight W is placed on a rough inclined plane at an angle of measure θ to the horizontal , it is found that the weight is about to slide down , then the magnitude of the force along the line of the greatest slope which makes the weight about to move upwards is equal to ....

(a) W sin θ (b) 2 W cos θ (c) 2 W sin θ (d) 4 W cos θ

---

8 A body of weight 39 newton is placed on a horizontal rough plane and if the tangent of the angle of friction between the body and the plane equals $\frac{1}{3}$, the body is pulled by a force inclines to the horizontal plane with an angle whose sine is $\frac{4}{5}$ that makes the body about to move , then the magnitude of the limiting static friction force = ... newton.

(a) 13 (b) 9 (c) 8 (d) 15

---

9 Three forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$, $\overrightarrow{F_3}$ act at the point (2 , 3) if $\overrightarrow{F_1} = 2\hat{i} + 4\hat{j}$, $\overrightarrow{F_2} = \hat{i} - 2\hat{j}$, $\overrightarrow{F_3} = -3\hat{i} + 4\hat{j}$, then the sum of the moments of these forces about the origin point equals ....

(a) $6\hat{k}$ (b) $12\hat{k}$ (c) $-6\hat{k}$ (d) $-12\hat{k}$

---

10 $\overline{AB}$ is a uniform ladder of weight (W) kg.wt. rests at its end A on a rough horizontal ground and it rests at the end B against a rough vertical wall such that the ladder is in a vertical plane perpendicular to the wall and it is inclined at the horizontal with an angle of measure 45° , if the coefficient of static friction between the ladder and the ground equals $\frac{3}{7}$, then the coefficient of static friction between the ladder and the wall if the ladder is about to move = ...

(a) $\frac{1}{7}$ (b) $\frac{3}{7}$ (c) $\frac{2}{7}$ (d) $\frac{1}{3}$

11. ABCD is a square , its side length 10 cm. , forces of magnitudes 4 , 9 , 4 , 9 newton act along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$, $\overrightarrow{AD}$ respectively , two other forces act at A and C , the magnitude of each is $5\sqrt{2}$ newton in directions $\overrightarrow{BD}$, $\overrightarrow{DB}$ respectively. If the system is equivalent to a couple , then the norm of its moment = ... newton. cm.

(a) 180 (b) 30 (c) 230 (d) 150

---

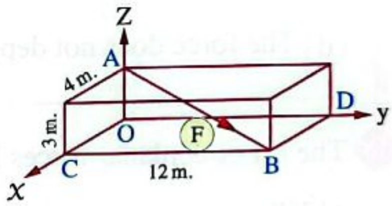
12. Two like forces of magnitudes F and 2 F act at the two points A and B. If the force of magnitude 2 F moves parallel to itself in the direction of $\overrightarrow{AB}$ a distance x cm. , then the resultant of the two forces moves in the same direction a distance = ...

(a) $\frac{2}{3}x$ (b) $\frac{3}{2}x$ (c) $\frac{4}{3}x$ (d) x

---

13. **In the opposite figure :**

A force of a magnitude 130 newton acts along the diagonal $\overline{AB}$ in the cuboid whose dimensions are 3 m. , 4 m. and 12 m.



, then the moment of the force $\vec{F}$ about point D = ...

(a) $-120\hat{j} + 480\hat{k}$ (b) $720\hat{i} + 120\hat{j} + 480\hat{k}$

(c) $120\hat{j} + 480\hat{k}$ (d) $720\hat{i} - 120\hat{j} - 480\hat{k}$

---

14. A fine lamina of uniform thickness and density in the form of a circular disc whose centre is the origin point and radius 24 cm. , two circular discs the centre of one to them is $(-2 , -12)$ and radius 4 cm. where the centre of the other disc is $(6 , 10)$ and the radius 12 cm. are cut off , then the centre of gravity of the remaining part of the disc is ....

(a) $(-3 , -2)$ (b) $(-2 , -3)$ (c) $\left(\frac{-11}{26} , \frac{-51}{13}\right)$ (d) $\left(\frac{28}{23} , \frac{51}{23}\right)$

---

15. A uniform squared lamina of weight (W) is suspended freely from the vertex A and a weight of $\left(\frac{1}{4} W\right)$ is fixed at vertex B , then the tangent of the angle of inclination of the diagonal $\overline{AC}$ to the vertical in the equilibrium position is equal to ....

(a) $\frac{2}{3}$ (b) $\frac{1}{4}$ (c) $\frac{1}{5}$ (d) $\frac{1}{6}$

16 The magnitude of the resultant of two parallel forces is 30 newton and the magnitude of one of the forces is 50 newton and acts at a distance of 12 cm. from the resultant , then the distance between the lines of action of the two forces = ... cm. if the known force and the resultant have opposite direction.

(a) 4.5 (b) 7.5 (c) 19.5 (d) 16.5

---

17 The dimensions of a cuboid box are 30 cm. , 40 cm. , 50 cm. its required to drag on a rough horizontal ground , the coefficient of friction between the box and the ground is $\frac{1}{4}$, which face should placed on the ground to drag the box with the least force ?

(a) On the face whose dimensions 30 cm. , 40 cm.

(b) On the face whose dimensions 40 cm. , 50 cm.

(c) On the face whose dimensions 30 cm. , 50 cm.

(d) The force does not depend on the area of contact with the ground.

---

18 The set of coplanar forces in the same plane as the Δ ABC , if the forces are in equilibrium , then ....

(a) $M_A + M_B + M_C = \text{zero}$ (b) $M_A + M_B = 2\,M_C$

(c) $M_A = M_B = M_C = \text{zero}$ (d) all the previous.

---

19 Parallel forces of magnitudes 5 , 8 , 12 N act in the same direction at the points A (2 , −2) , B (0 , 3) , C (4 , − 1) respectively , then the point of action of their resultant is ....

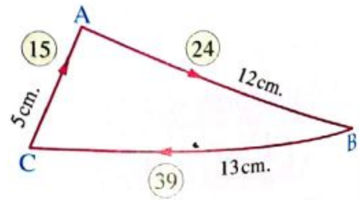
(a) (6 , 0) (b) $\left(\frac{58}{25} , \frac{2}{25}\right)$

(c) $\left(\frac{2}{25} , \frac{57}{25}\right)$ (d) (2 , 0)

---

20 **In the opposite figure :**

If the magnitudes of the forces are given in newton then the magnitude of the force should be added to the system to produce a couple equals ....

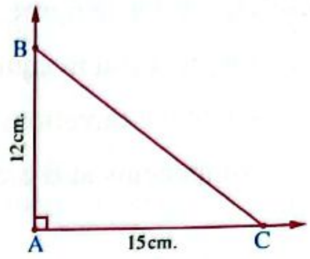


(a) 2 N in $\overrightarrow{AB}$ direction. (b) 12 N in $\overrightarrow{BA}$ direction.

(c) 12 N in $\overrightarrow{AB}$ direction. (d) 36 N in $\overrightarrow{AB}$ direction.

21 The centre of gravity of the following system.

With respect to point A is ....



Mass	20 mg.	40 mg.	30 mg.
Position	at A	at B	at C

ⓐ $(5, 4)$ ⓑ $\left(5, \frac{16}{3}\right)$

ⓒ $\left(\frac{7}{3}, \frac{10}{3}\right)$ ⓓ $\left(\frac{7}{2}, 6\right)$

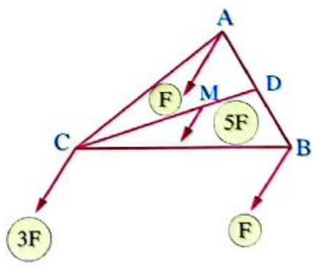
22 **In the opposite figure :**

A metal uniform beam of length 1 m. and weight 1 kg.wt. An iron uniform ball of weight $\frac{1}{2}$ kg.wt. and diameter length 20 cm. is fixed at the end A , then the centre of gravity of the system is at a distance .... cm. from B

ⓐ 50 ⓑ 60

ⓒ 15 ⓓ 70

23 **In the opposite figure :**

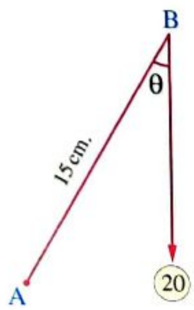


ABC is a triangle , M is the point of concurrent of its medians F , F , 5 F , 3 F are parallel forces act in the same direction and their lines of action lie on the triangle plane , the median length $\overline{CD} = 30$ cm. , then the resultant of these forces acts at a point at a distance .... cm. from C

ⓐ 14 ⓑ 15

ⓒ 16 ⓓ 20

24 **In the opposite figure :**

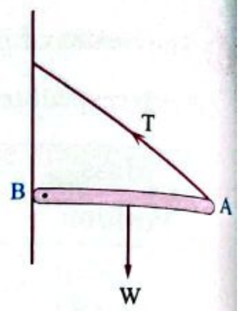


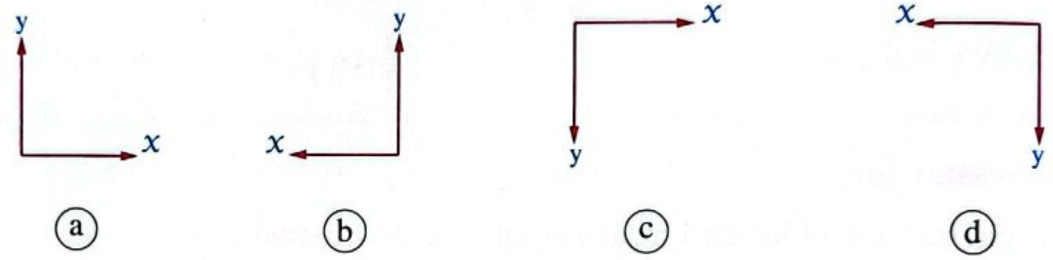
Magnitude of the moment of the force 20 newton. about the point A ∈..............

ⓐ $[0, 15]$ ⓑ $[0, 20]$

ⓒ $[0, 30]$ ⓓ $[0, 300]$

25 The opposite figure represents a regular rod in equilibrium , then the directions of hinge reaction components at B are ....





Answer the following questions :

1. A body of weight 12 newton is placed on a horizontal rough plane , then the body is pulled by a horizontal force of magnitude $4\sqrt{3}$ newton which makes the body about to move , then the measure of the angle of friction between the body and the plane = ...

(a) 30° (b) 45° (c) 60° (d) 75°

---

2. If $\vec{F} = (-1 , 3 , -2)$ acts at the point $(4 , -1 , 0)$, then the component of the moment of $\vec{F}$ about z-axis equals ....

(a) − 8 (b) 3 (c) 11 (d) 13

---

3. The centre of gravity of a uniform fine lamina in the shape of triangle ABC where A (1 , 2) , B (− 1 , 0) , C (3 , 1) is the point ....

(a) (1 , 1) (b) (0 , 0) (c) (2 , 2) (d) (3 , 3)

---

4. Two parallel forces are in the same direction and of magnitudes 7 and 10 newton act at the two points A and B where AB = 51 cm. If their resultant acts at the point C , then AC = ... cm.

(a) 12 (b) 21 (c) 27 (d) 30

---

5. A uniform ladder of weight 16 kg.wt. and of length (2ℓ) m. rests with one of its two ends against a smooth vertical wall and with the other end on a rough horizontal ground such that it lies on a vertical plane perpendicular to the wall and inclined to the horizontal with an angle of measure 45° , if the coefficient of static friction between the ladder and the ground equals 0.75 , then the horizontal force acting at the lower end of the ladder so that the motion is about to begin away from the wall = ... kg.wt.

(a) 4 (b) 20 (c) 8 (d) 12

6 ABC is a right-angled triangle at B in which AB = 6 cm. , BC = 8 cm.

, the force $\vec{F}$ acts in the plane of the triangle such that $M_A = M_B = 60$ newton.cm.

, $M_C = -60$ newton.cm. , then the magnitude of $\vec{F}$ = ... newton.

(a) 20 (b) 15 (c) 30 (d) 12.5

---

7 If the two forces $\vec{F_1} = 6\,\hat{i} - b\,\hat{j} + 9\,\hat{k}$ and $\vec{F_2} = 2\,a\,\hat{i} - 4\,\hat{j} + 3\,c\,\hat{k}$ form a couple

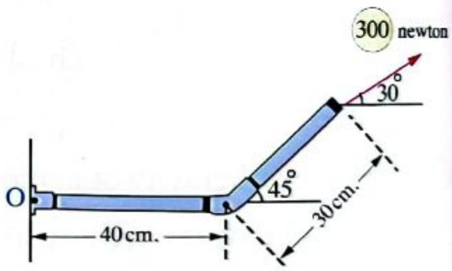
, then (a , b , c) is ....

(a) (– 3 , – 4 , – 3) (b) (3 , 4 , 3)

(c) (3 , – 4 , – 3) (d) (– 3 , 4 , 3)

---

8 **In the opposite figure :**



The algebraic measure of the moment of the force 300 newton about the point O (0 , 0) ≈ .... newton.cm.

(a) 3670.63 (b) 1748.5

(c) – 3670.6 (d) – 1748.5

---

9 A body of weight 3 newton is placed on a plane inclined at 30° to the horizontal and the coefficient of static friction between the body and the plane is $\frac{2}{3}$, a force of magnitude 2 newton is acting on the body upwards along the line of the greatest slope. Given that the body is at rest , then the force of friction = ... newton.

(a) $\frac{1}{2}$ (b) $1\frac{1}{2}$ (c) $3\frac{1}{2}$ (d) 2

---

10 A uniform rod of length 180 cm. and weight 60 newton is suspended in a horizontal position at its two ends A and B by two vertical strings , then a body of weight 150 newton is suspended at the point C on the rod if the magnitude of the tension in the string at A is twice the magnitude of the tension in the string at B , then AC = ... cm.

(a) 48 (b) 132 (c) 120 (d) [illegible]

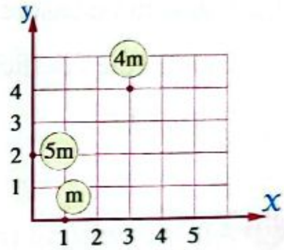
11 If the vector of the resultant of a set of forces is $\overrightarrow{R}$ and the vector of sum of the moments of the forces about one point in their plane is $\overrightarrow{M}$, then the condition of equilibrium of a set of coplanar forces is ....

(a) $\overrightarrow{R} = \overrightarrow{O}$, $\overrightarrow{M} = \overrightarrow{O}$
(b) $\overrightarrow{R} \neq \overrightarrow{O}$, $\overrightarrow{M} = \overrightarrow{O}$
(c) $\overrightarrow{R} = \overrightarrow{O}$, $\overrightarrow{M} \neq \overrightarrow{O}$
(d) $\overrightarrow{R} \neq \overrightarrow{O}$, $\overrightarrow{M} \neq \overrightarrow{O}$

12 ABC is an equilateral triangle of side length 8 cm. , a force of magnitude 15 newton acts at $\overrightarrow{BC}$, then the norm of the moment of this force about the point A equals .... newton.cm.

(a) $40\sqrt{3}$
(b) 60
(c) $60\sqrt{3}$
(d) 120

13 **In the opposite figure :**



Three masses m , 4 m , 5 m , then the centre of gravity of the system lies on the point ....

(a) $\left(\frac{13}{10} , \frac{13}{5}\right)$
(b) $\left(\frac{18}{10} , \frac{37}{10}\right)$
(c) $\left(\frac{17}{10} , \frac{27}{10}\right)$
(d) $\left(\frac{26}{10} , \frac{13}{10}\right)$

14 ABC is a fine lamina of uniform thickness and density in the form of a right-angled triangle at B where AB = 12 cm. , BC = 20 cm. and X , Y and Z are the midpoints of $\overline{AB}$, $\overline{BC}$ and $\overline{CA}$ respectively. The triangle CYZ is cut off and coincided with the triangle YBX if the system is freely suspended from point B , then the tangent of the angle of inclination of $\overline{BC}$ to the vertical in the equilibrium position = ...

(a) $\frac{2}{75}$
(b) $\frac{25}{24}$
(c) $\frac{75}{2}$
(d) $\frac{24}{25}$

15 ABCD is a rectangle in which AB = 120 cm. , BC = 50 cm. , forces of magnitudes 50 , 10 , 50 , 10 newton act along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$, $\overrightarrow{AD}$ respectively , then the magnitude of the two forces which act at B and D perpendicular to $\overline{BD}$ such that the system is in equilibrium = ... newton.

(a) 20 , 20
(b) 5 , 5
(c) 10 , 10
(d) 40 , 40

16 Forces $\overrightarrow{F_1} = 2\hat{i} - 4\hat{j}$, $\overrightarrow{F_2} = \hat{i} - 3\hat{j}$, $\overrightarrow{F_3} = -3\hat{i} + 7\hat{j}$ act at the points A (– 1 , 1) , B (– 2 , 3) , C (0 , 1) respectively if this system is equivalent to a couple , then its moment norm = ...

(a) 4
(b) 8
(c) 2
(d) 6

17 ABC is a triangle in which AB = AC = 13 cm. , BC = 24 cm. forces of magnitudes 39 , 72 , 39 newton act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CA}$ respectively if the system is equivalent to a couple , then the norm of its moment = ... newton. cm.

(a) 720 (b) 360 (c) 180 (d) 60

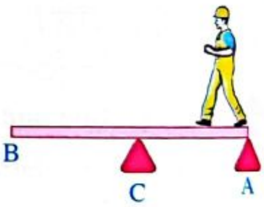
18 Two parallel forces are in opposite directions and of magnitudes 5 and 12 newton , then the magnitude of their resultant = ... N.

(a) 7 (b) 13 (c) 17 (d) 60

19 If λ is the measure of the angle between force of limiting friction and resultant reaction , then μ (the coefficient of static friction) = ...

(a) $\tan \lambda$ (b) $\sin \lambda$ (c) $\cos \lambda$ (d) $\cot \lambda$

20 $\overline{AB}$ is a uniform rod rest horizontally on two supports , one of them at A and the other at the midpoint of the rod C. Man moves on the rod from A towards B , then ....



(a) the rod will disturb its equilibrium when the man just passes the point A

(b) the rod will disturb its equilibrium when the man just passes the point C

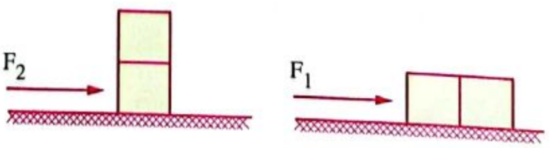
(c) the rod will disturb its equilibrium before the man reach at point C

(d) the rod remains in equilibrium even the man reaches to B

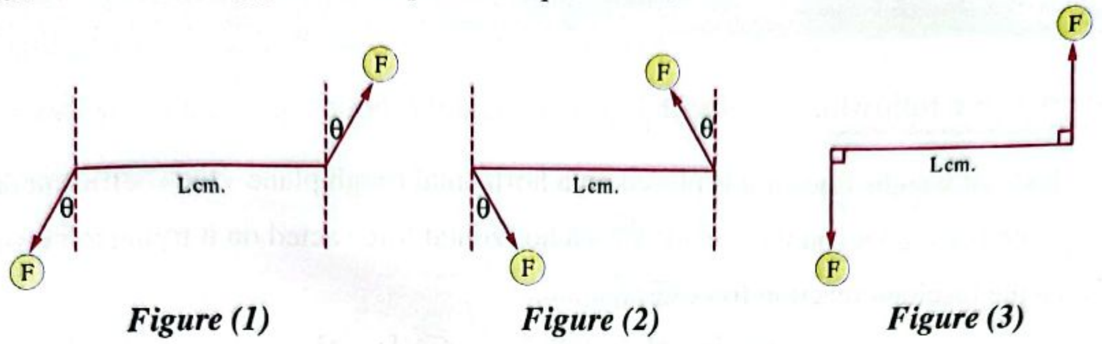
21 The following two shapes show two bricks of the same material equal in mass and volume , placed on a horizontal rough plane in two different positions force F acts on them to make them about to move , then ....

(a) $F_1 < F_2$ (b) $F_1 > F_2$

(c) $F_1 = F_2$ (d) can not compare between them.



22 Which of the following pair of couples are equivalent ?



(a) Figure (1) , (2) (b) Figure (2) , (3) (c) Figure (1) , (3) (d) All figures.

---

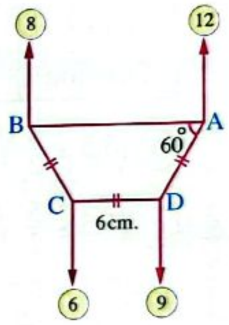
23 **In the opposite figure :**

ABCD is a trapezium

AD = DC = CB = 6 cm. , m (∠ DAB) = 60°

parallel forces of magnitude 12 , 8 , 6 , 9 N. act at its vertices A , B , C , D respectively

as shown then the resultant of these forces acts at a distance .... cm. from A



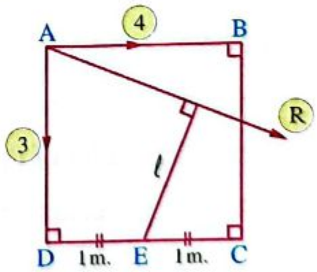
(a) 2 (b) 3 (c) 4 (d) 5

---

24 **In the opposite figure :**

ABCD is a square of side length 2 m. , two forces 4 , 3 kg.wt. act along , $\overrightarrow{AB}$, $\overrightarrow{AD}$ respectively

If their resultant $\overrightarrow{R}$, ℓ is the length of the perpendicular from E to the line of action of $\overrightarrow{R}$, then ....



(a) R = 5 kg.wt. , ℓ = 1.5 m.

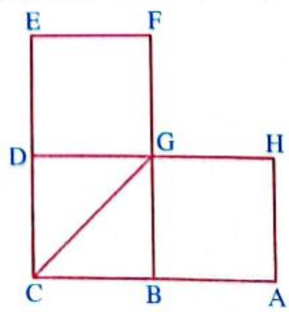
(b) R = 5 kg.wt. , ℓ = 1 m.

(c) R = 5 kg.wt. , $\ell = \sqrt{2}$ m.

(d) R = 5 kg.wt. , ℓ = 1.2 m.

---

25 The opposite figure represents a lamina in form of three identical squares. If it is suspended from C , then the vertical line is ....



(a) $\overline{BG}$

(b) $\overline{DG}$

(c) $\overline{BH}$

(d) $\overline{BE}$

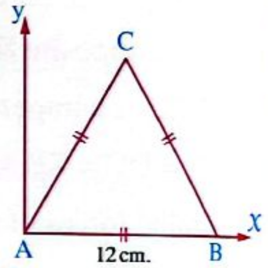
Answer the following questions :

1 A body of weight 1 newton is placed on a horizontal rough plane , the coefficient of friction between it and the body is $\sqrt{3}$, a horizontal force acted on it trying to move it , then the resultant reaction force $\in$ ....

(a) $]0 , 1]$ (b) $]1 , 2]$ (c) $\{1 , 2\}$ (d) $\{2\}$

2 The centre of gravity of the following system is at ....

Mass	4 mg.	5 mg.	3 mg.
Position	at A	at B	at C



(a) $\left(6.5 , \frac{3}{2}\sqrt{3}\right)$ (b) $\left(6.5 , 6\sqrt{3}\right)$

(c) $\left(6.5 , \frac{5}{2}\sqrt{3}\right)$ (d) $\left(9 , 3\sqrt{3}\right)$

3 If the force $\vec{F} = 3\hat{i} - 4\hat{j}$ acts at the point A (3 , – 1) , then the length of the perpendicular drawn from the point B (8 , – 4) to the line of action of this force equals ....

(a) 2 (b) 3

(c) 4 (d) 2.2

4 The magnitudes of the two parallel forces are F , 36 newton and their resultant of magnitude 84 newton and acts in opposite direction of second force and at a distance 30 cm. from it , then the distance between the two lines of action of the two forces = ... cm.

(a) 9 (b) 21

(c) 39 (d) 51

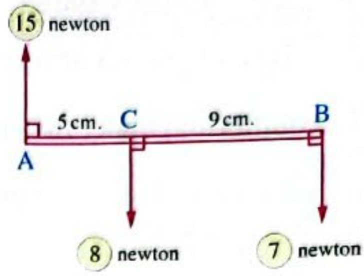
5 A 240 kg. weight is placed on a horizontal rough plane and is pulled by a string which makes an angle of measure 30° with horizontal. If the coefficient of static friction is 0.3 , then the tension that makes the motion about to begin $\simeq$ .... kg.wt.

(a) 70.86 (b) 204.57

(c) 184.6 (d) 64.95

6 **In the opposite figure :**

The algebraic measure of the moment of the couple of set of forces which act on the rod $\overline{AB}$ measured by unit of newton.cm. equals ....



(a) – 138 (b) – 58

(c) 58 (d) 138

7 A uniform ladder of weight 15 kg.wt. and length $(2\,\ell)$ m. rests with one of its two ends on a rough horizontal ground and with the other end on a smooth vertical wall such that the ladder lies on a vertical plane perpendicular to the wall and it is about to slide when the measure of the inclination angle to the horizontal 45° , then the coefficient of static friction between the ladder and the ground = ...

(a) 2 (b) $\frac{1}{2}$ (c) $\frac{1}{3}$ (d) $\frac{2}{3}$

8 A fine lamina of a uniform density bounded by the triangle ABC in which AB = BC = 9 cm. , m (∠ B) = 90° If the triangle ABM where M is the centre of gravity of the lamina is cut off and the remaining part is freely suspended from point B , then the tangent of the angle of inclination of $\overline{BC}$ to the vertical in the equilibrium position = ...

(a) $\frac{8}{5}$ (b) $\frac{5}{8}$ (c) 4 (d) $\frac{1}{4}$

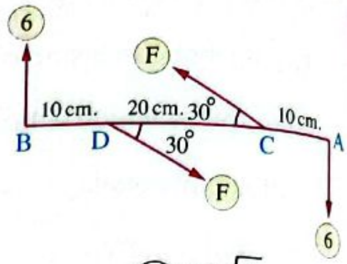
9 ABCD is a square of side length 4 cm. The masses 6 , 4 , 3 and 2 gm. are attached at A , B , C and D respectively. Another mass of magnitude 10 gm. is attached at the midpoint of $\overline{AB}$, then the distance between the centre of gravity of the system and the point C = ... cm.

(a) 3.2 (b) 2.08 (c) 5 (d) $\frac{4\sqrt{569}}{25}$

10 $\overline{AB}$ is a uniform rod of length 60 cm. and of weight 30 newton , it is suspended in a horizontal position at its two ends by two vertical strings and carries two weights one of them is 10 newton , at a distant 10 cm. from the end A and the other 20 newton at 20 cm. distant from the end B , then $T_A - T_B$ = ... newton.

(a) 30 (b) 40 (c) 60 (d) zero

11 **In the opposite figure :**



$\overline{AB}$ is a light rod of length 40 cm. If the rod is in equilibrium under the effect of the four forces (in newton), then F = ... newton.

(a) $\frac{16\sqrt{3}}{3}$ (b) 24 (c) 12 (d) $12\sqrt{3}$

---

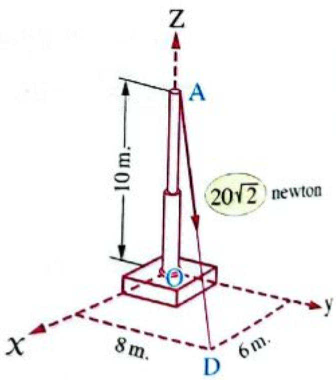
12 A body of weight 38 kg. wt. is about to move under its own weight when placed on a rough plane which is inclined to the horizontal with an angle whose tangent is $\frac{1}{4}$

If the body is placed on a horizontal plane which is as rough as the inclined plane and is acted on it by an upward pull force in a direction inclined to the horizontal with an angle whose tan is $\frac{3}{4}$ so that the motion is about to begin, then the magnitude of this force = ... kg.wt.

(a) 10 (b) $\frac{95}{8}$ (c) $\frac{25}{8}$ (d) 2

---

13 **In the opposite figure :**



A force of magnitude $20\sqrt{2}$ N. acts at point A, then the moment of the force about O = ...

(a) $-160\,\hat{i} - 120\,\hat{j}$

(b) $-160\,\hat{i} + 120\,\hat{j}$

(c) $120\,\hat{k}$

(d) $160\,\hat{i} - 120\,\hat{j}$

---

14 ABCD is a square of side length 3 cm. Forces of magnitudes 10, 15, 10, 15 newton act along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$, $\overrightarrow{AD}$ respectively also two equal forces of magnitude $5\sqrt{2}$ newton act on the two points A, C in the two directions $\overrightarrow{BD}$, $\overrightarrow{DB}$ respectively, then the two forces F, F acting at B and D parallels $\overline{AC}$ in opposite directions such that the system is in equilibrium, then F = ... newton.

(a) $15\sqrt{2}$ (b) $\frac{15\sqrt{2}}{2}$ (c) 15 (d) $\frac{35\sqrt{2}}{2}$

15 Two parallel forces are in opposite directions , the magnitude of one of them is 7 newton and the magnitude of their resultant is 10 newton , then the magnitude of the other force = ... newton.

(a) 3 (b) 6 (c) 17 (d) 27

---

16 A body of weight (W) is about to move on a rough horizontal plane by a horizontal force of magnitude (P) , the coefficient of static friction between the body and the plane is μ , then another body of weight (W + 3) made of the same material would be about to move on the same horizontal plane if a horizontal force of magnitude .... acts on it.

(a) P + 3 (b) 3 P (c) P^3 (d) $P + 3\mu$

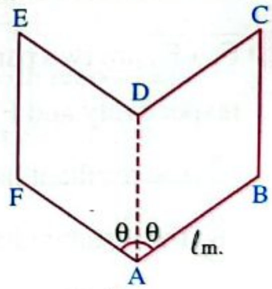
---

17 If $\vec{F} = 3\,i - 2\,j$, A (– 1 , 2) , the moment of $\vec{F}$ about A is $\vec{M}_A = 9\,\vec{k}$, the moment of $\vec{F}$ about B is $\vec{M}_B = 9\,\vec{k}$, then the coordinates of the point B can be represented by one of the following ordered pairs except ....

(a) (5 , – 2) (b) (2 , 0) (c) (– 8 , 4) (d) (8 , – 4)

---

18 **In the opposite figure :**



A uniform lamina in form of two rhombuses sharing in $\overline{AD}$.

If the side length of the rhombus = ℓ m. , m (∠ DAB) = θ

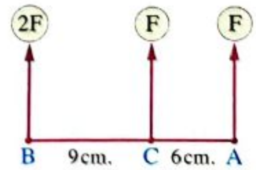
and the centre of gravity of the system above A by (0.9 ℓ) m.

, then cos θ = ...

(a) $\frac{3}{5}$ (b) $\frac{4}{5}$ (c) $\frac{4}{3}$ (d) $\frac{3}{4}$

---

19 The resultant of the parallel forces in the opposite figure acts at D ∈ $\overline{AB}$ where ....

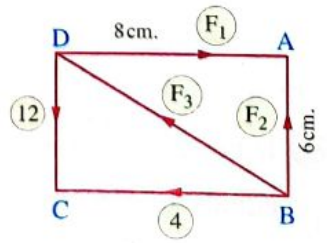


(a) D coincides with C (b) DA = 9 cm.

(c) DB = 7 cm. (d) DC = 1 cm.

---

20 **In the opposite figure :**



If the magnitude of the forces in newton and the system is in equilibrium ,

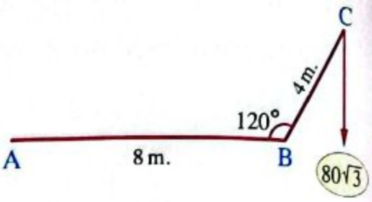
then $F_1 + F_2$ = ... newton.

(a) 19 (b) 16

(c) 8 (d) 11

21 **In the opposite figure :**

The algebraic measure of the force $80\sqrt{3}$ N. about A equals .... N. m.



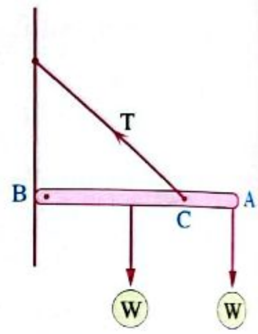
ⓐ $-80\sqrt{3}$ ⓑ $-800\sqrt{3}$

ⓒ -480 ⓓ $-480-640\sqrt{3}$

---

22 $\overline{AB}$ is a uniform rod , its end B is hinged to a vertical wall. The rod is suspended from a point C far from A quarter the rod length and the rod is in equilibrium in horizontal position.

If a load of weight as many as the rod is suspended at A , then the reaction of the hinge is ....



ⓐ ← ⓑ ↑ ⓒ → ⓓ ↗

---

23 $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces act in the same direction they are acting at A and B respectively and $F_1 > F_2$, if the magnitude of each has doubled then ....

ⓐ the resultant has doubled but its point of action does not change.

ⓑ the resultant has doubled and its point of action moves towards $\overrightarrow{F_1}$

ⓒ the resultant has doubled and its point of action moves towards $\overrightarrow{F_2}$

ⓓ the resultant has no effect and its point of action does not change.

---

24 ABCD is a trapezium in which $\overline{AD} \parallel \overline{BC}$, $\overline{AB}$ is perpendicular to them. E is the projection of D on $\overline{BC}$, CB = 15 cm. , BA = 8 cm. , AD = 9 cm. Forces of magnitudes 12 , 18 , 20 , 12 , 34 newton act along $\overrightarrow{AB}$, $\overrightarrow{AD}$, $\overrightarrow{DC}$, $\overrightarrow{ED}$, $\overrightarrow{CA}$ respectively , then the system of forces is equivalent to a couple and the magnitude of its moment = ... N.cm.

ⓐ 27 ⓑ 36 ⓒ 45 ⓓ 54

---

25 If $\overrightarrow{F} = 2\hat{i} + \ell\hat{j} - \hat{k}$ acts at point A (4 , −2 , 0) and the moment of $\overrightarrow{F}$ about the origin equals $2\hat{i} + 4\hat{j} + 16\hat{k}$, then ℓ = ...

ⓐ 1 ⓑ 2 ⓒ 3

Practice Exams

Exam 10

Answer the following questions :

1. If a force $\overrightarrow{F} = 2\hat{i} - \hat{j} + 5\hat{k}$ acts at the point A (1 , 0 , – 3) , then the moment of $\overrightarrow{F}$ about the point B which its position vector is $\hat{j} + 3\hat{k}$ equals ....

   (a) $-2\hat{i} - 17\hat{j} + \hat{k}$
   (b) $-11\hat{i} + \hat{k}$
   (c) $-11\hat{i} - 17\hat{j} + \hat{k}$
   (d) $-11\hat{i} - 17\hat{j}$

---

2. The resultant of two parallel forces is 40 newton , one of the two forces 60 newton and acts at a distance 24 cm. far from the action line of the resultant , then the distance between the two forces = ... cm. if the given force and the resultant act in the same direction.

   (a) 48
   (b) 24
   (c) 72
   (d) 20

---

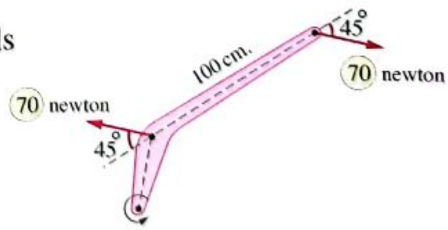
3. If the force $\overrightarrow{F} = k\hat{i} + m\hat{j} - 2\hat{k}$ acts at point A whose position vector with respect to the origin point is $\overrightarrow{r} = (3 , 1 , 1)$ if the two components of the moment of $\overrightarrow{F}$ about x and y-axes are – 1 and – 8 respectively , then k + m = ...

   (a) – 15
   (b) 15
   (c) 13
   (d) – 13

---

4. **In the opposite figure :**

   The algebraic measure of the moment of the couple equals .... newton. cm.



   (a) – 7000
   (b) $-3500\sqrt{2}$
   (c) $3500\sqrt{2}$
   (d) 7000

---

5. If the norm of the moment of a couple is 24 newton. m. and the arm length of the moment of the couple is 3 m. , then the magnitude of one of its two forces equals .... newton.

   (a) 8
   (b) 21
   (c) 27
   (d) 72

6) $\overline{AB}$ is a ruler of length 100 cm. and of weight (w) newton acting at its midpoint , it is suspended in a horizontal position by two vertical strings from its ends. At what point of the ruler a weight of (5 w) newton should be suspended so that the tension of one of the two strings twice the tension of the other string.

(a) At a distance 15 cm. from one of the ends.

(b) At a distance 30 cm. from one of the ends.

(c) At a distance 10 cm. from one of the ends.

(d) At a distance 20 cm. from one of the ends.

---

7) A uniform rod rests with its upper end a against a smooth vertical wall and its lower end on a horizontal plane , the coefficient of static friction between it and the rod equals $\frac{1}{4}$, then the tangent of the angle which the rod makes with the horizontal when it is about to slide = ...

(a) 2 (b) $\frac{1}{2}$ (c) $\frac{1}{4}$ (d) 4

---

8) A uniform fine lamina is in the form of a rectangle in which AB = 18 cm. , BC = 24 cm. , the Δ ABE is separated where E is the midpoint of $\overline{AD}$, then the remaining part is suspended freely from C , then the tangent of the angle of inclination of $\overline{CB}$ to the vertical in the equilibrium position = ...

(a) $\frac{7}{6}$ (b) $\frac{12}{17}$ (c) $\frac{17}{12}$ (d) $\frac{6}{7}$

---

9) A body is placed on a rough plane which is inclined to the horizontal with an angle of measure θ , the measure of the angle of friction is λ , then the body is still in equilibrium if and only if ....

(a) $\theta > \lambda$ (b) $\theta \geq \lambda$ (c) $\theta \leq \lambda$ (d) $\theta < \lambda$

---

10) ABCD is a rhombus of side length 12 cm. , m ($\angle$ A) = 60° , forces of magnitudes 11 , 6 , 5 , 7 newton act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{DB}$ respectively , then the sum of algebraic magnitudes of the moments of these forces about A equals .... newton.cm.

(a) $12\sqrt{3}$ (b) $24\sqrt{3}$ (c) $36\sqrt{3}$ (d) $48\sqrt{3}$

11 ABCDE is a regular pentagon of side length 15 cm. Forces each of magnitude 10 kg.wt. act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DE}$ and $\overrightarrow{EA}$ respectively. If the system is equivalent to a couple , then the magnitude of its moment ≈ .... kg.wt.cm.

(a) 516.14 (b) 258.1 (c) 272.45 (d) 136.23

12 $\overline{AB}$ is a rod of length 50 cm. and of weight 20 newton acting at its midpoint. It can rotate in a vertical plane about a fixed hinge at its end A , a couple of measure moment 250 newton. cm. acts in the vertical plane , then the inclination angle of the rod to the vertical in the equilibrium position = ...

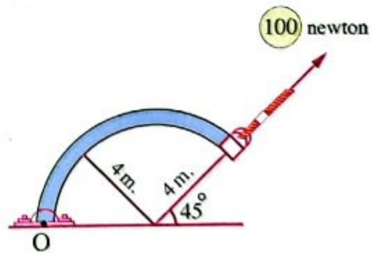
(a) 60° or 120° (b) 30° or 150° (c) 45° or 135° (d) 90°

13 $\overline{AB}$ is a non uniform rod of length 30 cm. , rests horizontally on two supports at C and D where AC = CD = DB. If a weight of magnitude 6 kg.wt. is suspended at A , then the rod is about to rotate about C. and if a weight 9 kg.wt. is suspended at B , then the rod is about to rotate about D , then the distance between the point of action of the weight of the rod and the end A = ... cm.

(a) 10 (b) 4 (c) 14 (d) 6

14 **In the opposite figure :**

The algebraic measure of the moment of the force 100 newton about (O) = ... newton.m.



(a) $100\sqrt{2}$ (b) 200

(c) $200\sqrt{2}$ (d) $400\sqrt{2}$

15 A body of weight (w) is placed on a rough inclined plane makes an angle of sine $\frac{5}{13}$ with the horizontal. The body is attached by a horizontal force of magnitude 22 newtons lies in the vertical plane which passes through the line of the greatest slope makes the body is about to move upwards the plane , if the static coefficient friction between the body and the plane is $\frac{1}{2}$, then the magnitude of the weight (w) = ... newton.

(a) 19 (b) 209 (c) 29 (d) 3

16 A body of weight 27 kg.wt. is placed on a horizontal rough plane , given that the coefficient of static friction between the body and the plane is $\frac{1}{3}$, then the magnitude of the force parallel to the plane which makes the body about to begin motion = ... newton.

(a) 9 (b) 88.2 (c) 81 (d) 793.8

17 Two bodies of weights W_1 and W_2 and are connected with a light string coinciding on the line of the greatest slope of a rough plane , the two coefficients of static friction between the two bodies and the plane are μ_1 and μ_2 respectively. If θ is the measure of the angle of inclination of the plane and this measure increases gradually. Show which of the two bodies should be put below the other to move together and the string connecting them is tensioned , when the two bodies are about to slide ?

(a) The heavier body.

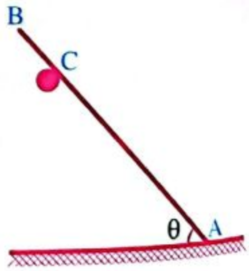
(b) The lighter body.

(c) The body with greater coefficient of friction.

(d) The body with smaller coefficient of friction.

18 **In the opposite figure :**

$\overline{AB}$ is a uniform of length 24 cm. and weight 50 gm.wt. rests with end A on a rough horizontal plane and one of its points (C) on a smooth pivot where BC = 4 cm. The rod is kept in equilibrium when it makes angle θ with the horizontal where $\tan\theta = \frac{3}{4}$, then the pivot reaction = ... gm.wt.



(a) 24 (b) 18 (c) 30 (d) 20

19 If $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces where $\overrightarrow{F_1} = (1 , m)$, $\overrightarrow{F_2} = (m^2 , -8)$, then m = ...

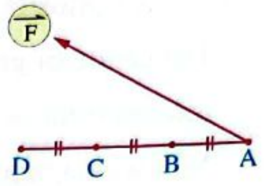
(a) 8 (b) -8 (c) 2 (d) -2

20 Three masses 3kg. , 2kg. , m kg. are placed at the points (6 , 4) , (3.5 , 5) , (1 , 2) respectively. The centre of gravity of the system at the point (3 , y) , then y = ...

(a) 3 (b) 3.2 (c) 3.4 (d) -3.2

21 **In the opposite figure :**

If the magnitude of the moments of $\overrightarrow{F}$ about each of B , C , D are M_B , M_C , M_D respectively. Which of the following statements is not true ?



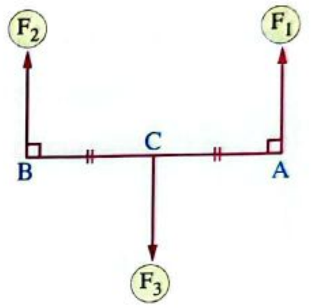
(a) $M_A = M_B = M_C$
(b) $M_B + M_C = M_D$
(c) $M_B + M_D = 2\ M_C$
(d) $M_B : M_C : M_D = 1 : 2 : 3$

---

22 **In the opposite figure :**

Three parallel forces equal in magnitude.

If the force F_3 has moved in $\overrightarrow{CA}$ direction a distance x , then the resultant ....

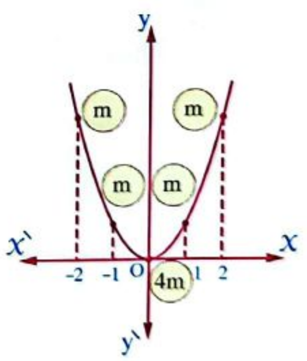


(a) remains as it is.
(b) moves in $\overrightarrow{CA}$ direction a distance x
(c) moves in $\overrightarrow{CA}$ direction a distance $\frac{1}{2}\ x$
(d) moves in $\overrightarrow{CB}$ direction a distance x

---

23 **In the opposite figure :**

Five masses m , m , 4 m , m , m are fixed on the curve of the function $f : f(x) = 2\ x^2$ as shown in the figure , then the centre of gravity of the system = ...

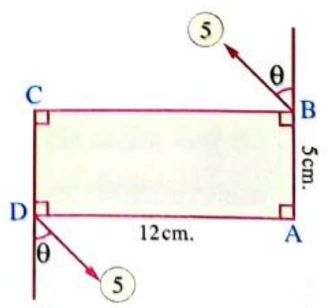


(a) (0 , 2.5)
(b) (0 , 3)
(c) (0 , 5)
(d) (0 , 5.5)

---

24 **In the opposite figure :**

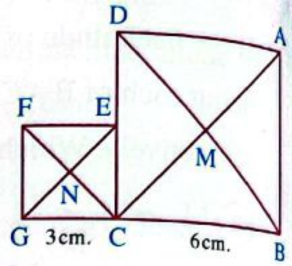
ABCD is a rectangle in which AB = 5 cm. , BC = 12 cm. , the algebraic measure of the couple moment produced by the two forces 5 , 5 newton shown in the figure equals 65 newton.cm. , then $\tan\theta$ = ...



(a) undefined.
(b) zero
(c) $\frac{5}{12}$
(d) $\frac{4}{3}$

25 In the opposite figure :

The centre of gravity of the lamina formed from two squares divides $\overline{MN}$ with a ratio .... from M



(a) 1 : 2
(b) 2 : 1
(c) 1 : 4
(d) 4 : 1

Practice Exams

Exam 11

Answer the following questions :

1 If the force $\overrightarrow{F} = 4\hat{i} - 3\hat{j}$ acts at the point A (2 , 3) , then the vector moment of this force with respect to the point B (– 1 , 2) equals ....

(a) $-13\hat{k}$ (b) $-5\hat{k}$ (c) $5\hat{k}$ (d) $13\hat{k}$

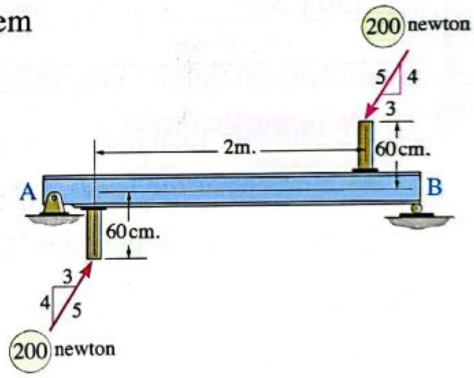
---

2 ABCD is a fine uniform lamina in the shape of rectangle , its weight 4800 gm.wt. , AB = 6 cm. , BC = 8 cm. A weight 1200 gm.wt. is placed at the vertex B and if the system is suspended freely from the vertex C , then in the equilibrium position the tangent of the angle of inclination of $\overline{CB}$ to the vertical = ...

(a) $\frac{1}{2}$ (b) 2 (c) $\frac{1}{3}$ (d) 3

---

3 The magnitude of the moment of the couple of the system of forces shown in the opposite figure in newton.m. equals ....



(a) 144

(b) 176

(c) 320

(d) – 17600

---

4 If the limiting friction force 60 newton and coefficient of static friction is 0.75 , then magnitude of the resultant reaction when the body is about to move equals .... newton.

(a) 60 (b) 80 (c) 100 (d) 200

---

5 The magnitude of the smaller one of two parallel forces is 60 newton acts at the end A of a light rod $\overline{AB}$. While the larger one acts at the other end B. If the magnitude of their resultant is 20 newton and its line of action is at a distance of 120 cm. from the end B , then the length of the rod $\overline{AB}$ = ... cm.

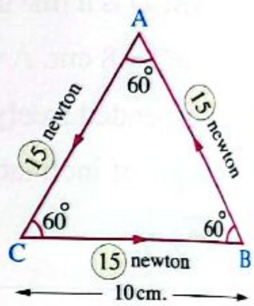
(a) 40 (b) 160 (c) 20 (d) 120

6 A uniform ladder of weight 32 kg.wt. and of length (2 L) rests in a vertical plane with one end against a smooth wall and the other end on a rough horizontal floor. and the inclination of the ladder to the floor is 45° and the magnitude of the smallest horizontal force acting at the lower end of the ladder so that the motion is about to begin away from the wall equals 4 kg.wt. , then the coefficient of static friction between the ladder and floor = ...

(a) $\frac{1}{4}$ (b) $\frac{5}{8}$ (c) $\frac{1}{3}$ (d) $\frac{1}{2}$

---

7 The magnitude of the couple moment of the shown system of forces in the opposite figure in newton.cm. equals ....

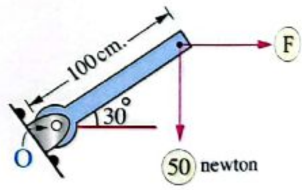


(a) $37.5\sqrt{3}$
(b) $75\sqrt{3}$
(c) $100\sqrt{3}$
(d) $150\sqrt{3}$

---

8 **In the opposite figure :**

If the moment of the force F about "O" equals the moment of the force 50 newton about "O" , then F = ... newton.



(a) $50\sqrt{3}$ (b) $25\sqrt{3}$
(c) $12.5\sqrt{3}$ (d) 50

---

9 Two parallel forces of magnitudes F_1 , F_2 act in the same direction at the two points A and B respectively. If the force $\overrightarrow{F_1}$ moves parallel to itself a distance = x on the ray $\overrightarrow{AB}$, then their resultant moves a distance equals .... in the same direction of moving.

(a) $\frac{F_2}{F_1 + F_2} x$ (b) $\frac{F_1 + F_2}{F_1} x$ (c) $\frac{F_2}{F_1} x$ (d) $\frac{F_1}{F_1 + F_2} x$

---

10 A thin uniform wire is formed as a right-angled triangle at B in which AB = 3 cm. , BC = 4 cm. , then the distance between centre of gravity of the wire and each of $\overline{BA}$, $\overline{BC}$ is ....

(a) (1.5 , 1) (b) (2 , 1.5) (c) $\left(\frac{8}{7} , \frac{9}{14}\right)$ (d) $\left(\frac{12}{7} , \frac{11}{14}\right)$

11 If R is the magnitude of the resultant of the two parallel forces whose magnitude 30 , F and R = 10 newton , then ....

(a) F = 20 newton and act in opposite direction of the force 30 newton.

(b) F = 20 newton and act in the same direction of the force 30 newton.

(c) F = 40 newton and act in opposite direction of the resultant.

(d) F = 40 newton and act in the same direction of the force 30 newton.

---

12 A body of weight 25 kg.wt. is placed on a rough inclined plane and is acted on it by a force F along the line of the greatest slope towards the top of the plane. Given that the motion is about to begin upwards when F = 15 kg.wt. and it is about to begin downwards when F = 10 kg.wt. , then the angle of inclination of the plane to the horizontal = ...

(a) $30°$ (b) $60°$ (c) $45°$ (d) $26° \, 34'$

---

13 A body of weight W newton is placed on a horizontal rough plane where the measure of the angle of friction is λ , the body is pulled by a force making an angle of measure 2λ with the horizontal upwards , it makes the body about to begin motion , then the magnitude of this force is ....

(a) $W \sin \lambda$ (b) $W \tan \lambda$ (c) $W \cot \lambda$ (d) $W \cos \lambda$

---

14 $\overline{AB}$ is a rod of length 100 cm. and of weight 3 kg.wt. acting at its midpoint. It can rotate in a vertical plane about a fixed hinge at its end A , a couple of magnitude moment 75 kg.wt.cm. acts in the vertical plane , then the inclination angle of the rod to the vertical in the equilibrium position = ...

(a) $30°$ or $150°$ (b) $60°$ or $120°$ (c) $90°$ (d) $45°$ or $135°$

---

15 ABCD is a rectangle in which AB = 9 cm. , BC = 24 cm. , X is the midpoint of $\overline{BC}$, the forces of magnitudes 27 , 36 , 45 newton act along $\overrightarrow{AB}$, $\overrightarrow{BX}$, $\overrightarrow{XA}$ respectively. If the system equivalent to a couple , then the magnitude of its moment = ... newton. cm.

(a) 324 (b) 648 (c) 162 (d) 216

16 A body of weight 52 N. is placed on a rough horizontal plane. The coefficient of static friction between the body and the plane = $\frac{1}{4}$. Two horizontal forces of magnitudes 8 N. , P N. including an angle of measure 60° act on it. Then the body will be about to move if P = ... newtons.

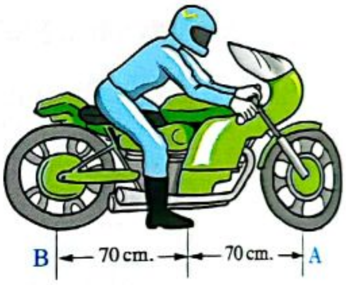
(a) 7 (b) 8 (c) 13 (d) 15

17 If the moment of the force $\vec{F} = 2\hat{i} + 3\hat{j} - k$ about origin equals $-5\hat{i} + 3\hat{j} - \hat{k}$ and the force passes through the point (m , 2 , k) , then the value of $m^2 + k$ = ...

(a) 8 (b) 4 (c) 2 (d) 1

18 **In the opposite figure :**

A motorcycle of mass 200 kg. and its weight acts at the vertical line passing through the midpoint between the centres of the two wheels and if the mass of the motorcyclist is 84 kg. and its weight acts on the vertical line distant 1 metre behind the centre of the front wheel , then the reaction of the ground on each of the two wheels = ... kg.wt.



(a) 100 , 124 (b) 100 , 160 (c) 124 , 160 (d) 160 , 180

19 If the two forces $\overrightarrow{F_1} = a\hat{i} + b\hat{j}$, $\overrightarrow{F_2} = (13 \text{ N.}, \theta°)$ form a couple where $\sin\theta = \frac{5}{13}$, then a + b = ...

(a) 7 or 17 (b) 7 or – 17 (c) – 7 or 17 (d) – 7 or – 17

20 The centre of gravity of the following system $m_1 = 1$ at (2 , 3) , $m_2 = 2$ at (– 2 , 1) , $m_3 = 3$ at (0 , 1) is ....

(a) $\left(\frac{-1}{3}, \frac{4}{3}\right)$ (b) $\left(\frac{7}{6}, \frac{4}{3}\right)$ (c) $\left(\frac{-1}{3}, \frac{2}{3}\right)$ (d) (0 , 1)

21 A system consists of two laminas equal in thickness and density in form of two circles touching externally. If their equations are $C_1 : x^2 + y^2 - 2x = 8$, $C_2 : (x - 10)^2 + y^2 = K$, then the centre of gravity of the system is ....

(a) inside C_1 (b) inside C_2

(c) at the touching point. (d) outside the two circles.

22 If $\vec{F}$ is a force in the plane of parallelogram ABCD and $M_A = -18$ units of moment , $M_B = M_D = 32$ units of moment , then $M_C =$ .... unit of moment.

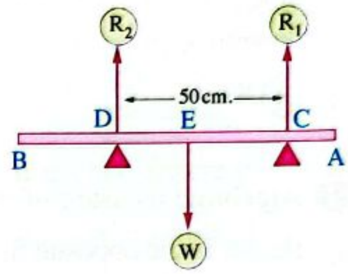
(a) 50 (b) 82 (c) 46 (d) 14

---

23 **In the opposite figure :**

$\overline{AB}$ is a uniform rod of length 100 cm. , CD = 50 cm.

, then AC = ... to make the reaction at $C = \frac{1}{4}$ the reaction at D



(a) 12.5 (b) 37.5

(c) 10 (d) 40

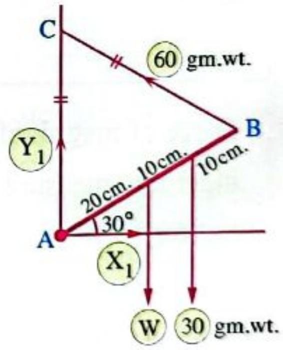
---

24 **In the opposite figure :**

If the rod $\overline{AB}$ is in equilibrium and AB = 40 cm.

, the tension in $\overline{BC}$ equals 60 gm.wt.

, then W = ... gm.wt.



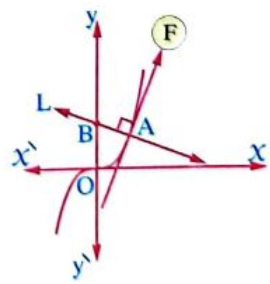
(a) 60 (b) 75

(c) 90 (d) 100

---

25 **In the opposite figure :**

Force of magnitude $6\sqrt{10}$ N. acts parallel to the tangent to the curve $y = x^3$ at the point A (1 , 1) as shown in the figure. If the straight line L is perpendicular to the tangent at (1 , 1) , then the moment of F about B equals .... moment unit.



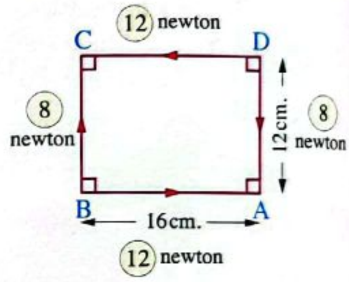
(a) 10 (b) 20 (c) $2\sqrt{10}$ (d) 180

Answer the following questions :

1. Two parallel forces have the same directions , one of them is twice the other and the magnitude of their resultant equals 24 newton , then the magnitude of the great force in newton = ...

(a) 8 (b) 12 (c) 16 (d) 18

2. Algebraic measure of the moment of the couple of the forces shown in the opposite figure in the unit of newton. cm. = ...



(a) – 96 (b) – 16

(c) 16 (d) 96

3. Force of magnitude 10 newton acts on $\overrightarrow{AB}$ where A (2 , 7) , B (5 , 3) , then the algebraic measure of its moment about the origin = ...

(a) 58 (b) 68 (c) – 58 (d) – 68

4. A , B , C , D are four collinear points such that AB = 2 BC = CD = 40 cm. parallel forces of magnitudes 20 , 30 , F_1 , F_2 act at the points A , B , C , D respectively such that the two forces 20 , F_2 act in one direction and opposite to the two forces 30 , F_1 and their resultant is 20 newton act in direction of F_1 and its line of action bisects $\overline{AD}$, then $F_1 + F_2$ = ... newton.

(a) 10 (b) 40 (c) 50 (d) 60

5. If $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two forces form a couple acting at the two points A (1 , 1) , B (– 1 , 2) respectively where $\overrightarrow{F_1} = 2\hat{i} + 5\hat{j}$, then the moment of the couple equals ....

(a) $-12\hat{k}$ (b) $-\hat{k}$ (c) $\hat{k}$ (d) $12\hat{k}$

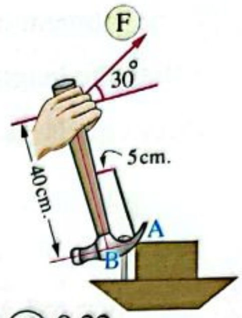
6. The distance between centre of gravity of a uniform thin lamina in the shape of an equilateral triangle whose side length is 12 cm. and one of the vertices of this triangle equals .... cm.

(a) $2\sqrt{3}$ (b) $4\sqrt{3}$ (c) 6 (d) $6\sqrt{3}$

7 The opposite figure illustrates the force $\vec{F}$ needed to remove a nail at B

If the magnitude of the moment of the force $\vec{F}$ about point A needed to remove the nail is equal to 200 newtons. cm.

, then the magnitude of the force $\vec{F} \approx$ .... newton.



(a) 5.38 (b) 6.22 (c) $\frac{10\sqrt{3}}{3}$ (d) 8.22

8 A body of weight 10 kg.wt. is placed on a rough horizontal plane. If the coefficient of static friction between the body and the plane is $\frac{1}{4}$ and a horizontal force of magnitude 2 kg.wt. act on it and if the magnitude of friction force is F , then ....

(a) $F < 2$ kg.wt. (b) $F = 2$ kg.wt.

(c) $2 < F < 2.5$ kg.wt. (d) $F = 2.5$ kg.wt.

9 ABC is a triangle in which AB = 7 cm. , BC = 8 cm. , m (∠ ABC) = 120°

Forces of magnitudes 17.5 , 20 , 32.5 newton act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CA}$ respectively. If the system of these forces is equivalent to a couple , then the magnitude of its moment = ... newton. cm.

(a) $70\sqrt{3}$ (b) $35\sqrt{3}$ (c) $140\sqrt{3}$ (d) 140

10 A body of weight $2\sqrt{57}$ kg.wt. is placed on a rough horizontal plane. Two forces of magnitudes 4 and 6 kg.wt. including between them an angle of measure 60° acted on the body , the two forces are horizontal and lying in the same horizontal plane with the body. If the body became about to move , then the coefficient of the static friction = ...

(a) $\frac{\sqrt{3}}{3}$ (b) $\sqrt{3}$ (c) $\frac{1}{2}$ (d) $\frac{1}{3}$

11 A body of mass 10 kg. is placed on a rough plane inclined to the horizontal with an angle of measure 30° , the body becomes about to slide down. If a force parallel to the plane which makes the body about to move upwards the plane , then the magnitude of this force = ... kg.wt.

(a) 5 (b) 10 (c) 20 (d) $5\sqrt{3}$

12 If the moment of the force $\vec{F} = 3\hat{i} + \hat{j} - 2\hat{k}$ about the point A is $\overrightarrow{M_A} = -3\hat{i} - \hat{j} - 5\hat{k}$, then the length of the perpendicular from this point to the line of action of the force equals .... length unit.

(a) $\frac{1}{5}\sqrt{10}$ (b) $\frac{1}{2}\sqrt{10}$ (c) $2\sqrt{10}$ (d) $10\sqrt{5}$

---

13 A uniform rod $\overline{AB}$ of length 140 cm. and weight 16 newton is suspended by two vertical strings from its terminals, then the distance from A at which a weight of 14 newton can be suspended from one point on the rod to make the tension at A is twice the tension at B is ....

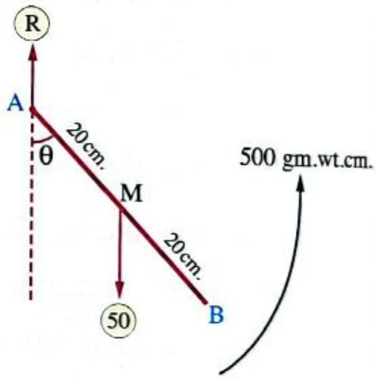
(a) 20 cm. From B (b) 50 cm. From A

(c) 20 cm. From A (d) 50 cm. From B

---

14 **In the opposite figure :**

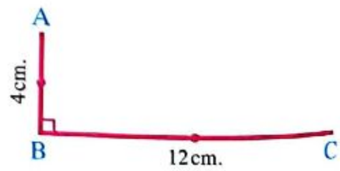
$\overline{AB}$ is a uniform rod of length 40 cm. and of weight 50 gm.wt. it can rotate easily in a vertical plane about a hinge at the end A. When the rod was in vertical position, a couple of algebraic measure of moment = 500 gm.wt. cm. acts on the rod where the couple acts in the same vertical plane passing through the rod, then in equilibrium position the measure of the angle with which the rod inclines to the vertical = ...



(a) 30° or 150° (b) 60° or 120° (c) 45° or 135° (d) 90°

---

15 The opposite figure represents a wire of a uniform density and thickness such that AB = 4 cm., BC = 12 cm., m (∠ B) = 90° If the wire is suspended freely from B, then the tangent of the angle of inclination of $\overleftrightarrow{BC}$ to the vertical in the equilibrium position is ....



(a) $\frac{1}{9}$ (b) $\frac{1}{3}$ (c) $\frac{1}{2}$ (d) 3

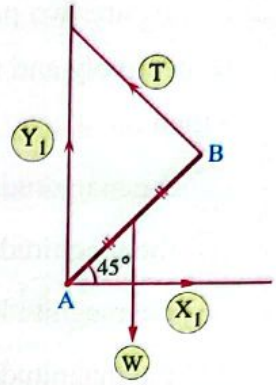
---

16 The centre of gravity of the following system of 3 distributed masses $m_1 = 1$ kg. at $G_1(0, 0)$, $m_2 = 1$ kg. at $G_2(3, 0)$, $m_3 = 2$ kg. at $G_3(3, 4)$

(a) $\left(3, \frac{8}{3}\right)$ (b) $\left(\frac{9}{4}, 2\right)$ (c) $(3, 2)$ (d) $\left(\frac{9}{4}, \frac{8}{3}\right)$

17 **In the opposite figure :**

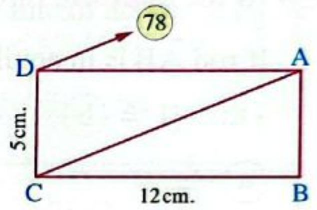
$\overline{AB}$ is a uniform rod of length ℓ unit and its weight W force unit , then $Y_1 - X_1 =$ .... force unit.



(a) $\frac{1}{2}$ W (b) $\frac{1}{3}$ W
(c) $\frac{2}{3}$ W (d) zero

---

18 The opposite figure represents a rectangle. The force of magnitude 78 N. acts at point D in direction parallel to $\overline{AC}$. Then the magnitude of the moment of the force about B = ... N. cm.



(a) 60 (b) 360
(c) 720 (d) 1440

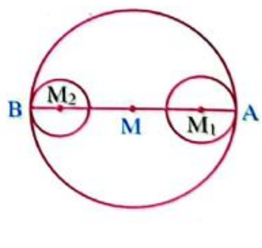
---

19 If θ is the measure of the angle between the normal reaction and the resultant reaction when the friction is limiting and 2 θ is the measure of the angle between the resultant reaction and the limiting static friction , then the coefficient of static friction = ...

(a) $\frac{\sqrt{3}}{3}$ (b) $\sqrt{3}$ (c) $\frac{\sqrt{3}}{2}$ (d) $\frac{1}{3}$

---

20 The opposite figure represents a circular disc whose centre is M , two circular discs are removed of it , their centres are M_1 , M_2 and their radii 3 cm. , 2 cm. respectively , then the centre of gravity of the remaining part lies on ....



(a) $\overline{MM_1}$ (b) $\overline{MM_2}$
(c) $\overline{AM_1}$ (d) $\overline{BM_2}$

---

21 The magnitude of moment of a couple is (M_1), if the magnitude of each forces is doubled and the perpendicular distance between them is halved , then the magnitude of moment of the new couple is (M_2) , then ....

(a) $M_1 = M_2$ (b) $M_1 = 2 M_2$ (c) $M_2 = 2 M_1$ (d) $M_1 = 4 M_2$

22 $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces act in the same direction they are acting at A and B respectively and their resultant acts at $C \in \overline{AB}$. If the magnitude of $\overrightarrow{F_1}$ increases , then ....

(a) the magnitude of the resultant increases and its point of action moves towards B

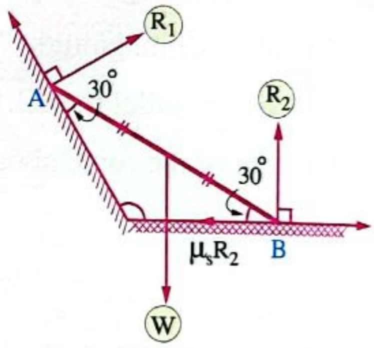
(b) the magnitude of the resultant increases and its point of action moves towards A

(c) the magnitude of the resultant does not increase and its point of action moves towards B

(d) the magnitude of the resultant does not increase and its point of action moves towards A

---

23 **In the opposite figure :**



If rod $\overline{AB}$ is in equilibrium , then μ_s = ...

(a) $\frac{3}{\sqrt{3}}$

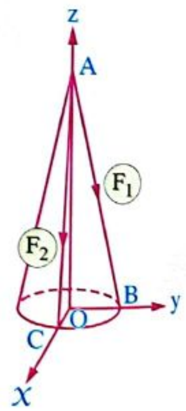
(b) $\frac{\sqrt{3}}{3}$

(c) $\frac{1}{3}$

(d) $\sqrt{3}$

---

24 **In the opposite figure :**



The base centre of a right circular cone lies at (O) and the radius of its base is 4 length unit and its volume = 48 π cubic unit. Two forces of magnitude $F_1 = 2\sqrt{97}$ N. , $F_2 = 3\sqrt{97}$ N. acts in $\overrightarrow{AB}$ and $\overrightarrow{AC}$ directions as shown in the figure then the moment of the resultant of the two forces about (O) = ...

(a) $-72\,\hat{i} + 108\,\hat{k}$

(b) $-72\,\hat{i} + 108\,\hat{j}$

(c) $-72\,\hat{j} + 108\,\hat{k}$

(d) $108\,\hat{i} - 72\,\hat{k}$

---

25 Parallel forces $\overrightarrow{F_1} = \hat{i} + m\,\hat{j}$, $\overrightarrow{F_2} = 3\,\hat{i} - 15\,\hat{j}$, $\overrightarrow{F_3} = n\,\hat{i} + 10\,\hat{j}$ act at the points A (3 , 1) , B (3 , 0) and C (3 , 5) respectively , then the equation of the line of action of their resultant is ....

(a) $10\,x + 2\,y - 21 = 0$

(b) $10\,x + 2\,y + 21 = 0$

(c) $5\,x + y - 10 = 0$

(d) $5\,x + y + 10 = 0$

Practice Exams

Exam 13

Answer the following questions :

1. If $\vec{F} = (-1 , 3 , -2)$ acts on the point $(4 , -1 , 0)$, then the component of the moment of $\vec{F}$ about the z-axis equals ....

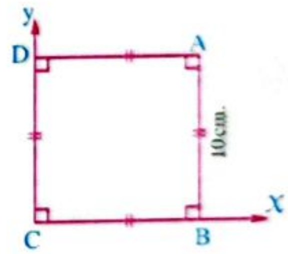
(a) -8 (b) 3 (c) 11 (d) 13

2. Two parallel forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$, magnitude of their resultant 70 newton and magnitude of the first force 50 newton and its line of action at a distance 30 cm. from the line of action of the resultant. If $\overrightarrow{F_1}$ and $\vec{R}$ have the same direction , then the line of action of $\overrightarrow{F_2}$ is at a distance .... from the line of action of the resultant.

(a) 75 cm. (b) 105 cm. (c) 30 cm. (d) 70 cm.

3. The centre of gravity of the following system is ....

Mass	20 gm.	30 gm.	10 gm.	40 gm.
Position	at A	at B	at C	at D



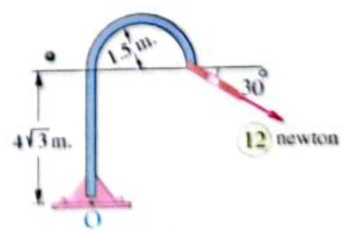
(a) $(4 , 7)$ (b) $(7 , 4)$
(c) $(5 , 6)$ (d) $(6 , 5)$

4. If the two forces $\overrightarrow{F_1} = 4\hat{i} - a\hat{j}$, $\overrightarrow{F_2} = 2b\hat{i} + 5\hat{j}$ form a couple , then $2a + b =$ ....

(a) -12 (b) -8 (c) 8 (d) 12

5. **In the opposite figure :**

The norm of the moment of the force whose magnitude is 12 newton with respect to the point "O" equals .... newton.m.



(a) 30 (b) 60 (c) 90 (d) 190

6. Two parallel forces 20 , F newton , if the magnitude of their resultant is 35 newton and the distance between line of action of the given force and the resultant equals 15 cm. and the given force and resultant acting in opposite directions , then the distance between the two lines of action of the force F and the resultant equals .... cm.

(a) $\frac{60}{11}$ (b) $\frac{105}{11}$ (c) $\frac{160}{11}$ (d) $\frac{225}{11}$

7 ABCD is a square whose diagonals intersect at M , forces of magnitudes 6 , F , k , 3 newton in the directions $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$, $\overrightarrow{AD}$ respectively if the algebraic sum of the moment of these forces about each of B and M is vanished , then F – K = ... newton.

(a) 3 (b) 6 (c) 12 (d) 9

---

8 A uniform ladder of weight 20 kg.wt. rests in a rough horizontal ground with one of its ends and the other end on a smooth vertical wall. The ladder is being kept in a vertical plane and inclined at 60° to the horizontal. If it is known that the coefficient of static friction between the ladder and the ground equals $\frac{1}{2\sqrt{3}}$, then the maximum distance that a girl of weight 60 kg.wt. can ascend up the ladder is equal to .... the length of the ladder.

(a) $\frac{1}{15}$ (b) $\frac{1}{2}$ (c) $\frac{1}{4}$ (d) $\frac{5}{8}$

---

9 ABCD is a rectangle in which AB = 8 cm. , BC = 12 cm. , E , F are the midpoints of $\overline{BC}$ and $\overline{AD}$ respectively , forces of magnitudes 24 , 36 , 30 , 18 newton act at $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CF}$, $\overrightarrow{FA}$ respectively. If the two forces F , F acting at $\overrightarrow{EA}$, $\overrightarrow{FC}$, then the system is in equilibrium , then F = ... newton.

(a) 90 (b) 45 (c) 180 (d) 120

---

10 If a body of weight (w) is placed on a rough inclined plane to the horizontal at an angle of measure θ , a force of magnitude (w) acted on the body in the line of the greatest slope upward to make the body about to move , then $\mu_s + \tan\theta =$ .... where μ_s is the static friction coefficient.

(a) sec θ (b) csc θ (c) sin θ (d) cos θ

---

11 A uniform thin lamina in the shape of isosceles triangle ABC in which AB = AC , $\overline{AD}$ is the height of the triangle where AD = 45 , a straight line is drawn parallel to $\overline{BC}$ and passing through the centre of gravity of the lamina to intersect $\overline{AB}$, $\overline{AC}$ at the points E , F respectively , then the centre of gravity of the quadrilateral EBCF is at a distance .... from the point D

(a) 7 (b) 15 (c) $\frac{145}{13}$ (d) 8

12 A uniform rod $\overline{AC}$ of the length $15\ \ell$ is bent from point B where $\overline{AB} = 5\ \ell$ such that $m(\angle ABC) = 90°$ and the rod is suspended freely from end A. If $\overline{BC}$ is inclined at an angle of α to the horizontal , then $\tan \alpha =$ ....

(a) $\frac{4}{5}$ (b) $\frac{5}{4}$ (c) 2 (d) $\frac{1}{2}$

---

13 $\overline{AB}$ is a uniform rod of length 120 cm. and weight 600 gm.wt is suspended in horizontal position by two vertical strings at the two points C , D on the rod where AC = 25 cm. , BD = 35 cm. and a weight F is suspended at the point E on it where AE = 30 cm. and the tension in the string at C is twice the tension in the string at D , then F = ... gm.wt.

(a) 800 (b) 200 (c) 600 (d) 400

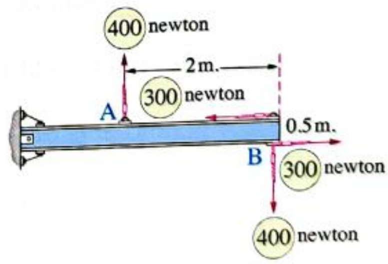
---

14 A body of weight 38 newton is placed on a horizontal rough plane and the tangent of the friction angle between the body and the plane is $\frac{1}{4}$, the body is pulled by a force make an angle with the horizontal of sine equals $\frac{3}{5}$ to make the body is about to move , then the magnitude of the resultant reaction = ... newton.

(a) 32 (b) 8 (c) 10 (d) $8\sqrt{17}$

---

15 The magnitude of the moment of the couple of the system of forces shown in the opposite figure equals .... newton.m.

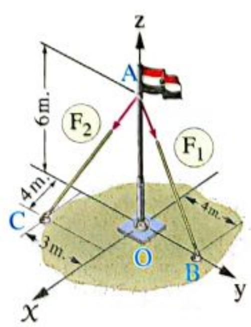


(a) 150 (b) 650

(c) 800 (d) 950

---

16 The force $F_1 = 6\sqrt{13}$ newton and $F_2 = \sqrt{61}$ newton in the direction of $\overrightarrow{AB}$ and $\overrightarrow{AC}$ as shown in the opposite figure , then the sum of the moments of the forces about point O = ...



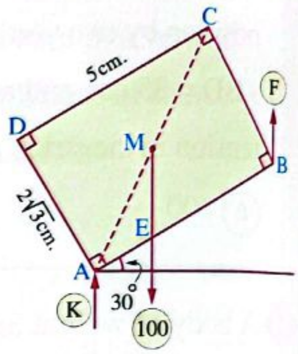
(a) $-54\,\hat{i} + 24\,\hat{j}$ (b) $-54\,\hat{i} - 24\,\hat{j}$

(c) $-72\,\hat{i} + 18\,\hat{j}$ (d) $-72\,\hat{i} + 24\,\hat{j}$

17 Force $\vec{F} = 3\hat{i} - 4\hat{j}$ acts at the point (0 , 2) and $\overrightarrow{BC} = (-4 , -2)$, the length of the perpendicular drawn from B to the line of action of $\vec{F}$ equals that drawn from C , then $\vec{M}_B + \vec{M}_C =$ ....

(a) $2\vec{M}_B$ (b) $\frac{1}{2}\vec{M}_B$ (c) $2\vec{M}_C$ (d) $\overrightarrow{zero}$

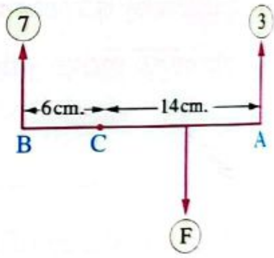
18 **In the opposite figure :**



If the lamina ABCD is in equilibrium under action of the shown forces , then K – F = ...

(a) 40 (b) 50
(c) 60 (d) 70

19 **In the opposite figure :**



Three forces, measured in newton act on a rod $\overline{AB}$ are in equilibrium. If the set form a couple , then ....

(a) F = 10 N. and acts at C

(b) F = 10 N. and acts at B

(c) F = 4 N. and acts at A

(d) F = 10 N. and acts at any point on the rod except C

20 A body of weight 80 N. is placed on a rough horizontal plane , the coefficient of static friction between the body and the plane = $\frac{3}{4}$ A horizontal force of magnitude 50 N. acts on it , then the ratio between the friction force and the limiting friction force = ...

(a) 3 : 4 (b) 3 : 5 (c) 5 : 6 (d) 6 : 5

21 The centre of gravity of a fine uniform circular lamina determined by the equation $x^2 + y^2 - 4x + 6y - 3 = 0$ lies at the point ....

(a) (– 4 , 6) (b) (4 , – 6) (c) (2 , 3) (d) (2 , – 3)

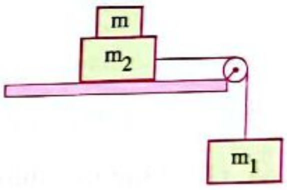
22 F_1 , F_2 are magnitude of two parallel forces acting in the same direction, if you switched their places, their resultant does not change its position , then ....

(a) $F_1 = F_2$ (b) $F_1 = 2\,F_2$ (c) $4\,F_1 = F_2$ (d) $F_1 = \frac{1}{2}\,F_2$

23 $\overline{AB}$ is a uniform rod of length 160 cm. and of weight 300 gm.wt. is hung at a fixed nail C by means of two strings tied at the ends A and B , a weight of magnitude 600 gm.wt. is suspended at the point N on the rod. If the rod is in equilibrium horizontally when the two strings $\overline{AC}$ and $\overline{BC}$ are inclined to the rod at two angles of measures 60° and 30° respectively , then the length of $\overline{AN}$ = ... cm.

(a) 10 (b) 20 (c) 30 (d) 40

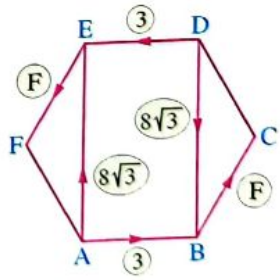
24 **In the opposite figure :**



If $m_1 = 5$ kg. , $m_2 = 10$ kg.
The coefficient of friction between m_2 and the horizontal plane = 0.15 , then the least mass m should be placed up on m_2 to keep the system in equilibrium equals .... kg.

(a) $18\frac{1}{3}$ (b) $23\frac{1}{3}$ (c) $10\frac{1}{3}$ (d) $43\frac{1}{3}$

25 **In the opposite figure :**



ABCDEF is a regular hexagon of side length 10 cm. The forces have magnitudes and directions shown in the figure are in equilibrium , then F = ... gm.wt.

(a) 3 (b) 5
(c) 8 (d) $8\sqrt{3}$

Answer the following questions :

1. A body of weight 12 newton is placed on a rough plane inclined to the horizontal by an angle of measure 60° if the coefficient of the static friction between the body and the plane $= \frac{\sqrt{3}}{9}$, then the body ....

   (a) remained at rest on the plane.
   (b) can't be at rest on the plane.
   (c) is about to move upward the plane.
   (d) is about to move downward the plane.

2. Two parallel forces have the same direction of magnitudes F_1 , F_2 Newton If $F_1 : F_2 = 1 : 2$ and their resultant = 15 newton , then $F_2 - F_1 =$ .... newton.

   (a) 5 (b) 7 – 5 (c) 10 (d) 15

3. If the magnitude of the moment of a couple is 30 newton. m and the length of its arm is 5 m. , then the magnitude of one of its forces in newton = ...

   (a) 6 (b) 25 (c) 35 (d) 10

4. ABCD is right trapezium at B , $\overline{AD} \,//\, \overline{BC}$, AB = 9 cm. , AD = 12 cm. , BC = 24 cm. , the point E is the midpoint of $\overline{BC}$, forces of magnitudes 27 , 72 , 45 , 36 newton acted on $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DA}$ respectively , if the two forces F , F act on $\overleftrightarrow{EA}$ and $\overleftrightarrow{DC}$ to make the system in equilibrium , then F = ...

   (a) 81 (b) 135 (c) 270 (d) 64.8

5. The two parallel forces $\overrightarrow{F_1} = 2\hat{i} - 3\hat{j}$ and $\overrightarrow{F_2}$ are acting at A (1 , 3) and B (4 , 9) respectively , if their resultant is acting at C (3 , 7) , then $\overrightarrow{F_2} =$ ....

   (a) $\hat{i} - \frac{3}{2}\hat{j}$ (b) $-4\hat{i} + 6\hat{j}$ (c) $4\hat{i} - 6\hat{j}$ (d) $4\hat{i} + 6\hat{j}$

6. If the coefficient of static friction between a body and a plane is 2 sin 30° , then the measure of the angle of friction = ...

   (a) 30° (b) 45° (c) 60° (d) 75°

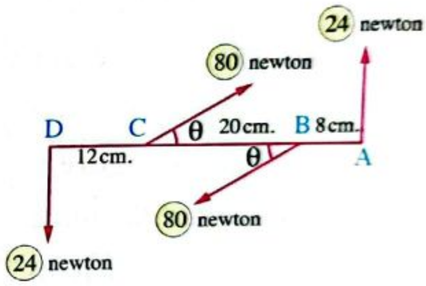
7. If the line of action of $\vec{F} \parallel \overline{AB}$, $\overrightarrow{M_A} = 15\,\hat{k}$, then $\overrightarrow{M_B} =$ ....

(a) $\vec{0}$ (b) $-5\,\hat{k}$ (c) $15\,\hat{k}$ (d) $30\,\hat{k}$

8. $\overline{AB}$ is a non uniform rod of length 70 cm. rests at its end B on a horizontal ground and at its end A on a vertical wall. If the coefficients of the static friction between the rod and each of the ground and wall are $\frac{1}{2}$, $\frac{1}{3}$ respectively , the rod was about to slide when the angle of its inclination with measure 45° , then the distance between the end B and the centre of gravity = ... cm. (knowing that the rod lies in a vertical plane perpendicular to the intersection line between wall and ground)

(a) 30 (b) 40 (c) $40\sqrt{2}$ (d) 35

9. If $\overline{AD}$ is an equilibrium rod under the effect of the shown system of forces in the opposite figure and if AB = 8 cm. , BC = 20 cm. , CD = 12 cm. , then $\sin\theta =$ ....



(a) 0.4 (b) 0.5
(c) 0.6 (d) 0.8

10. $\overline{AB}$ is non uniform rod of length 70 cm. and weight 4.5 kg.wt. rests in horizontal position on two smooth supports at C , D where AC = 12 cm. , BD = 14 cm.
It found that if a weight 6 kg.wt. suspended from the end A , then the rod is about to rotate , then the distance between the centre of gravity and the point C = ... cm.

(a) 16 (b) 28 (c) 42 (d) 23

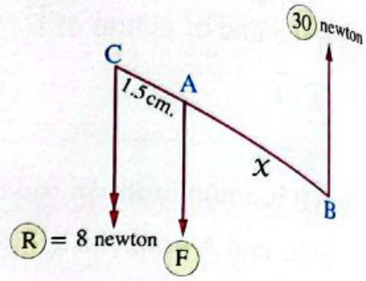
11. A body of weight 20 newton is placed on horizontal rough plane , the coefficient of the static friction between the body and the plane = $\frac{1}{4}$, then the force that inclined to the horizontal by an angle of measure 30° to make the body about to move = ... newton.

(a) 5.05 (b) 20 (c) $\frac{10\sqrt{3}}{3}$ (d) 14.6

12. A force $\vec{F}$ act at the point A (– 3 , 2) , if its moment with respect to each of B (3 , 1) , C (– 1 , 4) equals $28\,\hat{k}$, then $\vec{F} =$ ....

(a) $8\,\hat{i} + 6\,\hat{j}$ (b) $-8\,\hat{i} + 6\,\hat{j}$ (c) $-8\,\hat{i} - 6\,\hat{j}$ (d) $8\,\hat{i} - 6\,\hat{j}$

13 **In the opposite figure :**



If 30 , F newton are the magnitudes of two parallel forces their resultant is R , then x = ... cm.

(a) 5.5 (b) 4 (c) 0.8 (d) 0.4

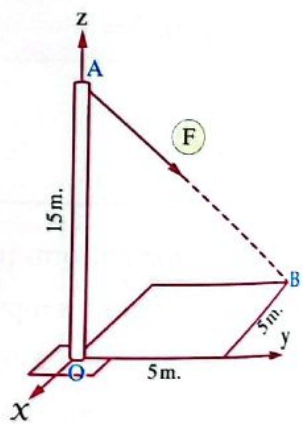
---

14 A uniform rod of length 140 cm. and weight 6 kg.wt. act on its midpoint can be rotate easily about a horizontal fixed nail passing through a small hole in the rod at the point C at a distance 35 cm. from the end B if the rod rests with its end A on a smooth horizontal table. The end B is pulled horizontally by a robe to make the reaction of the table equals to the weight of the rod , then magnitude of the reaction of the nail = ... newton (knowing that the angle of inclination of the rod to the horizontal is of measure 30°)

(a) $117.6\sqrt{3}$ (b) 12 (c) $12\sqrt{3}$ (d) 117.6

---

15 **In the opposite figure :**



The moment of the force F whose magnitude is $15\sqrt{11}$ newton about O equals ....

(a) $-225\,\hat{i} + 225\,\hat{j}$

(b) $-225\,\hat{i} - 225\,\hat{j}$

(c) $225\,\hat{i} + 225\,\hat{j}$

(d) $225\,\hat{i} + 225\,\hat{j} + 30\,\hat{k}$

---

16 A uniform wire of length 120 cm. and mass 600 gm. is bent to form a Δ ABC which is right angled at B where AB = 30 cm. If a mass m is fixed at the vertex A , then the wire is suspended freely at the vertex B to be equilibrium when $\overline{AC}$ is horizontally , then m = ... gm.

(a) 200 (b) 400 (c) 100 (d) 150

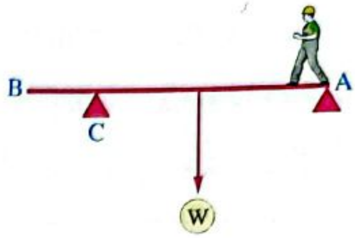
---

17 Two bodies of masses 6 kg. , 12 kg. and distance between them 90 cm. , then the distance of the centre of gravity of the two bodies with respect to the body 6 kg = ... cm.

(a) 60 (b) 30 (c) 15 (d) 45

18 **In the opposite figure :**

A uniform rod $\overline{AB}$ rests in a horizontal position on two supports one of them at A and the other at C on the rod. If a man moves from A towards B and the rod remains in equilibrium , then ....



(a) the reaction at A increases and the reaction at C decreases.

(b) the reaction at A decreases and the reaction at C increases.

(c) the reaction at A remains constant and the reaction at C remains constant.

(d) the reaction at A decreases till the man reaches to the rod centre then increases gradually.

---

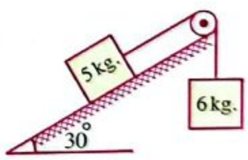
19 If a mass of 1 kg. is placed at the position A (2 , 1) , 2 kg. is placed at B (3 , 2) , 3 kg. is placed at C (– 4 , 5) and 4 kg. at D (x , y) the centre of the gravity of the system is the origin , then (x , y) = ...

(a) (1 , 5) (b) (2 , 3) (c) (1 , – 5) (d) (5 , – 1)

---

20 **In the opposite figure :**

A 5 kg. body is placed on a rough inclined plane, connected with light string passes over a smooth. Pulley at the edge of the plane and the other end of the string tied to a body of mass 6 kg. If the system is in equilibrium , then the magnitude and the direction of the friction force is ....

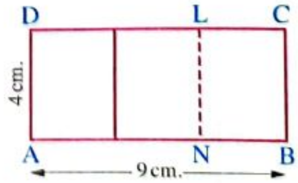


(a) 3.5 kg.wt. upward. (b) 3.5 kg.wt. downward.

(c) 8.5 kg.wt. upward. (d) 8.5 kg.wt. downward.

---

21 The opposite figure shows a fine uniform lamina in the form of a rectangle of dimensions 9 cm. , 4 cm. The lamina is divided into three congruent rectangles and the lamina is bent about $\overleftrightarrow{LN}$ such that the surface of region BCLN touched the surface of the remaining lamina, then the distance of the centre of gravity from $\overleftrightarrow{AD}$ is .... cm.



(a) 3 (b) $3\frac{1}{2}$ (c) 4 (d) 4.2

22. If $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are the two forces of a couple such that $\overrightarrow{F_1} = -3\hat{i} + 2\hat{j}$ acts at the point A (1 , 1) , $\overrightarrow{F_2}$ acts at the point B (−1 , −2) then the moment of the couple and the length of the arm drawn from A to the line of action of $\overrightarrow{F_2}$ are ....

(a) $13\hat{k}$, $\sqrt{13}$ length units.
(b) $-13\hat{k}$, $\sqrt{13}$ length units.
(c) $13\hat{k}$, $2\sqrt{13}$ length units.
(d) $-3\hat{k}$, $3\sqrt{13}$ length units.

---

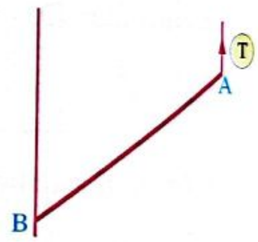
23. Two parallel forces in the same direction of magnitudes 3 N and 2 N act at the points A and B respectively where AB = 5 unit of length. The force 3 N is translated in direction of $\overrightarrow{BA}$ 3 units of length and the force 2 is translated in direction of $\overrightarrow{AB}$ two units of length , then the resultant is translated in direction .... distance .... length unit.

(a) $\overrightarrow{AB}$, 1
(b) $\overrightarrow{BA}$, 1
(c) $\overrightarrow{AB}$, 2
(d) $\overrightarrow{BA}$, 2

---

24. **In the opposite figure :**

$\overline{AB}$ is a rod hanged from its end (A) by a vertical string and its end (B) is hinged in a vertical wall then the reaction of the hinge is ....

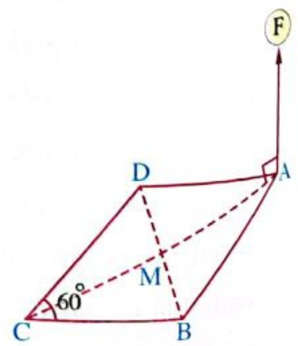


(a) perpendicular to wall.
(b) vertically downward.
(c) vertically upward.
(d) in $\overrightarrow{AB}$ direction.

---

25. **In the opposite figure :**

ABCD is a rhombus of side length 5 cm. Its diagonals intersect at M. Force of magnitude F N. acts at A perpendicular to the plane of the rhombus ABCD and its moment about C equals 300 N. cm. , then F = ... N.



(a) $10\sqrt{3}$
(b) $15\sqrt{3}$
(c) $20\sqrt{3}$
(d) $25\sqrt{3}$

Answer the following questions :

1. If a body is placed on a rough inclined plane and it became about sliding on the plane , then the tangent of the angle of friction equals each of the following except ....

(a) the static friction coefficient.

(b) the ratio between the magnitude of the normal reaction and the magnitude of the resultant reaction.

(c) the tangent of the inclination angle of the plane on the horizontal.

(d) the ratio between the limiting friction and the magnitude of the normal reaction.

---

2. If the line of action of $\overrightarrow{F} = \hat{i} + \hat{j}$ bisects $\overline{AB}$ where A = (3 , – 1) , and D = (1 , 4) is the midpoint of $\overline{AB}$, then $\overrightarrow{M_B}$ = ... $\hat{k}$

(a) – 7 (b) 7 (c) 3 (d) – 3.5

---

3. F_1 , F_2 are two forces where the magnitude of the first force = 4 kg.wt. and the magnitude of their resultant R = 6 kg.wt. the distance between F_1 and R = 8 cm. , then if F_1 and R act in the same direction , then the distance between F_1 and F_2 equals ....

(a) 12 cm. (b) 16 cm. (c) 20 cm. (d) 24 cm.

---

4. ABCDEF is a regular hexagon of side length 8 cm. Forces of magnitudes 3 , 8 , 3 , 8 kg.wt. act on $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{DE}$, $\overrightarrow{FE}$ respectively.

If the set of forces is equivalent to a couple , then the norm of its moment = ... kg.wt. cm.

(a) $40\sqrt{3}$ (b) $64\sqrt{3}$ (c) $88\sqrt{3}$ (d) $24\sqrt{3}$

---

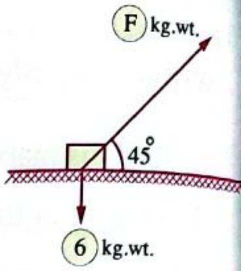
5. Three forces of magnitudes 10.5 , 12 , 19.5 newton are completely represented by the directed line segments $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CA}$ respectively of the triangle ABC in which AC = 13 cm. , then the norm of moment of the couple which is equivalent to the three forces = ... newton.cm.

(a) $42\sqrt{3}$ (b) 42 (c) $84\sqrt{3}$ (d) 84

6 **In the opposite figure :**

A body of weight 6 kg.wt. is placed on a horizontal rough plane , the coefficient of static friction between the body and the plane is $\frac{1}{2}$ A force of magnitude F kg.wt. acts on the body where it inclines with the plane by an angle of measure 45°

If the body is about to move, then F = ... kg.wt.



(a) $2\sqrt{2}$ (b) $3\sqrt{2}$ (c) $\frac{3}{\sqrt{2}}$ (d) $\frac{3\sqrt{2}}{2}$

---

7 A uniform ladder of weight 40 kg.wt. rests at one of its ends on a vertical smooth wall and the other end rests on a horizontal rough plane laying in the vertical plane perpendicular to the wall , such that it inclines at the horizon with an angle of measure 45° If a boy of weight equal that of the ladder ascended the ladder such that the ladder is about to slide when the boy covered $\frac{3}{4}$ the length of the ladder , then the coefficient of static friction between the ground and the ladder = ...

(a) $\frac{5}{8}$ (b) $\frac{1}{4}$ (c) $\frac{1}{2}$ (d) $\frac{3}{8}$

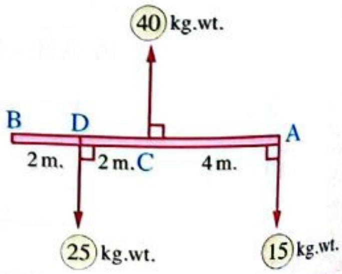
---

8 If the force $\overrightarrow{F} = 15\,\hat{i} - 25\,\hat{j} + 40\,\hat{k}$ acts at the point $(-3\ ,-3\ ,2)$, then the component of the moment of the force $\overrightarrow{F}$ about y-axis = ... moment unit.

(a) 100 (b) 150 (c) 250 (d) 400

---

9 The algebraic measure of the moment of the couple of the set of forces shown in the opposite figure equals .... kg.wt.m.



(a) – 60 (b) – 10
(c) 10 (d) 50

---

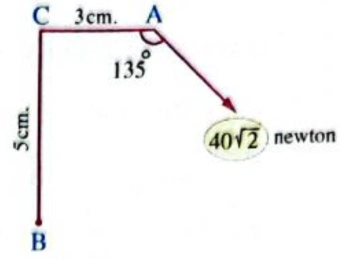
10 $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces act in opposite directions at the two points A and B respectively where $F_1 > F_2$ If the norm of its resultant equals 90 kg.wt. acting on $C \in \overleftrightarrow{BA}$ where AB = 36 cm. , AC = 16 cm. , then the magnitude of $\overrightarrow{F_1}$ = ...

(a) 130 (b) 292.5 (c) 260 (d) 20.8

11 **In the opposite figure :**

The magnitude of the moment of the force $F = 40\sqrt{2}$ newton.

about the point B equals .... newton.cm.



ⓐ 320 ⓑ $200\sqrt{2}$

ⓒ $120\sqrt{2}$ ⓓ $80\sqrt{16}$

---

12 A body of weight 4 kg.wt. is placed on a rough plane incline to the horizon with an angle of measure 30° , if the coefficient of static friction between the body and the plane is $\frac{\sqrt{3}}{2}$, then the force acting on the body in the direction of the greatest slope such that it makes the body about to move downward = ... kg.wt.

ⓐ 1 ⓑ 2

ⓒ 3 ⓓ 5

---

13 $\overline{AB}$ is a rod of length 24 cm. and of weight 5 kg.wt. acting at its midpoint. It can rotate easily in a vertical plane about a fixed horizontal nail passing through a small hall in the rod at the point C which is far from B with distance 4 cm. If the rod rests with its end A on a smooth horizontal table. The end B is pulled horizontally with a string till the reaction of the table became equal to the weight of the rod , then the reaction of the nail = ... kg.wt. (at this condition to make that the rod is kept in equilibrium at a position in which the rod inclines at the horizon with an angle of measure 30°)

ⓐ $15\sqrt{3}$ ⓑ $30\sqrt{3}$

ⓒ 30 ⓓ $7.5\sqrt{3}$

---

14 **In the opposite figure :**

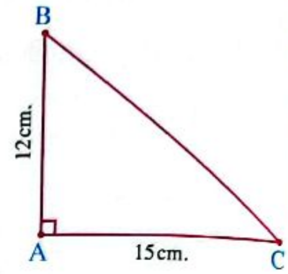
If the moment required to make the nail rotate about O equals 400 newton.cm. , then the least value of the force F which rotates the nail = ... newton.

ⓐ 40 ⓑ 20

ⓒ $20\sqrt{3}$ ⓓ 15

15 In the opposite figure :

The centre of gravity of the following system with respect to the point A is ....



The mass	20 gm.	40 gm.	30 gm.
The position	at A	at B	at C

(a) (5 , 4)
(b) $\left(5 , \frac{16}{3}\right)$
(c) $\left(\frac{7}{3} , \frac{10}{3}\right)$
(d) $\left(\frac{7}{2} , 6\right)$

---

16 $\overline{AB}$ is a uniform rod of length 50 cm. , supporting horizontally on two supporters C and D at a distance 10 , 40 cm. from the end A. If a weight = 60 newton is susbended at A , then the rod becomes about rotating about C , then the weight of the rod = ... newton.

(a) 40
(b) 80
(c) 120
(d) 20

---

17 A thin uniform wire in thickness and density , of length 40 cm. It is bent in the shape of the trapezium ABCD in which AB = 16 cm. , CD = 8 cm. , DA = 6 cm. , m (∠ DAB) = m (∠ CDA) = 90° Find the distance between the centre of gravity of this wire and the point A = ... cm.

(a) 7.4
(b) 2.4
(c) 7
(d) 3.5

---

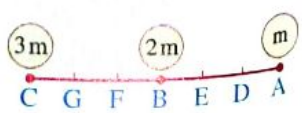
18 ABC is a triangular lamina of an equilateral triangle , of mass 3 kg. M is its centre of gravity masses of magnitudes 2 , 2 , 11 kg. are placed at the vertices A , B and C respectively and D is the midpoint of $\overline{AB}$, then the centre of gravity of this system lies at ....

(a) the midpoint of $\overline{MD}$
(b) the midpoint of $\overline{MC}$
(c) the point which divide $\overline{CD}$ by ratio 1 : 5
(d) the point which divide $\overline{CD}$ by ratio 5 : 1

---

19 In the opposite figure :

Three masses m , 2 m , 3 m fixed at A , B , C respectively , then the centre of gravity of the system lies at the point ....

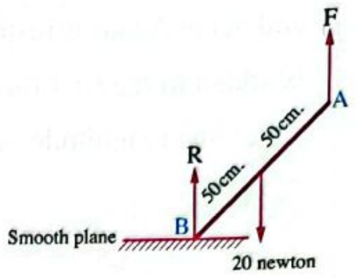


(a) E
(b) B
(c) F
(d) G

20 **In the opposite figure :**

$\overline{AB}$ is a uniform rod rests at its end B on a smooth plane. It is in equilibrium under action of the forces shown in the figure

, then F = ... N.



(a) 5 (b) 10

(c) 15 (d) 20

---

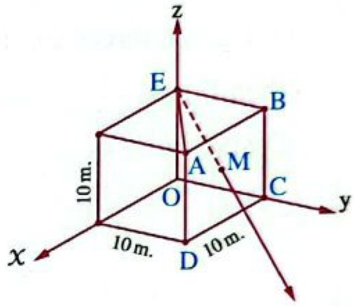
21 **In the opposite figure :**

Force of a magnitude $25\sqrt{6}$ newton acts in $\overrightarrow{EM}$

where M is the centre of square ABCD

, then the moment components of

the force with respect to the y-axis ....



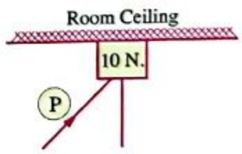
(a) – 500 (b) 250

(c) 125 (d) zero

---

22 **In the opposite figure :**

The weight of the body is 10 N. If P makes an angle of measure 30° to the vertical and it makes the body about to move on the ceiling of the room and the coefficient of static friction between the body and the ceiling $= \frac{\sqrt{3}}{2}$, then P = ... newtons.

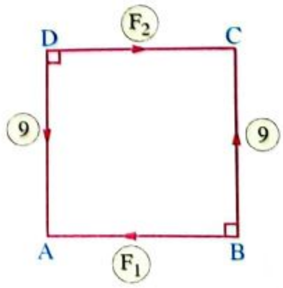


(a) $10\sqrt{3}$ (b) $15\sqrt{3}$ (c) $20\sqrt{3}$ (d) $30\sqrt{2}$

---

23 **In the opposite figure :**

ABCD is a square of side length 4 cm. , the forces of magnitudes and directions as shown in the figure act in its sides. If the system is equivalent to a couple , the magnitude of its moment = 20 newton.cm. , then $F_1 = F_2 =$ ....



(a) 4 or 14 (b) 14 or 56 (c) 4 or 56 (d) 56 or 32

24 Two parallel forces have same direction. The magnitude of the two forces 5 N. , 8 N. and act at A and B respectively where AB = 39 cm. If another force of magnitude F is added to the first force and in the same direction and the resultant moves 8 units , then the magnitude of F = ... N.

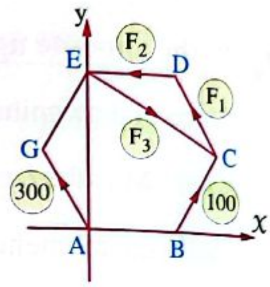
ⓐ 6.5 ⓑ 8 ⓒ 9.5 ⓓ 13

25 In the opposite figure :

ABCDEG is a uniform hexagon with side length 40 cm.

If the given forces are in equilibrium

, then F_2 = ... newton.

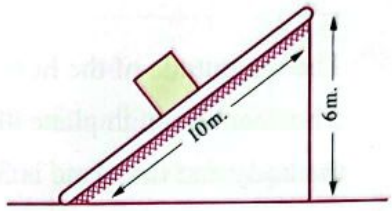


ⓐ 600 ⓑ $300\sqrt{3}$

ⓒ 100 ⓓ 150

Answer the following questions :

1 **In the opposite figure :**



The body is about to slide downwards the plane

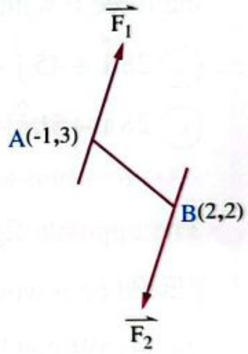
, then the static coefficient of friction = ...

(a) $\frac{3}{5}$ (b) $\frac{4}{5}$

(c) $\frac{3}{4}$ (d) $\frac{4}{3}$

---

2 **In the opposite figure :**



If $\overrightarrow{F_1} = 2\hat{i} + 5\hat{j}$, $\overrightarrow{F_2} = -2\hat{i} - 5\hat{j}$

act at the two points A and B

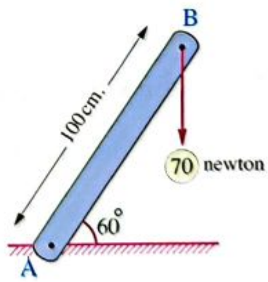
, then the moment of the couple equals ....

(a) $-17\hat{k}$ (b) $-13\hat{k}$

(c) $13\hat{k}$ (d) $17\hat{k}$

---

3 **In the opposite figure :**



A rod $\overline{AB}$ is fixed at a hinge at A , a vertical force of magnitude 70 N. acts at the end B downwards , then the magnitude of the moment of this force about the point A equals .... N.m.

(a) 35 (b) $35\sqrt{3}$

(c) 70 (d) $70\sqrt{3}$

---

4 Two parallel forces , their resultant = 12 gm.wt. The magnitude of one of these forces is 15 gm.wt. and acts at a distance 10 cm. from the resultant , then the distance between the two forces = ... cm. (if the given force acts in the same direction of the resultant)

(a) 20 (b) 40

(c) 15 (d) 30

5 If $\vec{F} = 3\hat{i} - 4\hat{j}$ acts at the point A (0 , 2) , If C = (2 , 3) , D = (– 2 , 1) , then the line of action of the force $\vec{F}$ ....

(a) bisects $\overline{CD}$ (b) parallels $\overline{CD}$ (c) bisects $\overline{AD}$ (d) bisects $\overline{AC}$

6 The magnitude of the horizontal force which makes a body of weight 15 kg.wt. placed on a horizontal rough plane about to move where the measure of the angle of friction between the body and the plane is 30° equals .... kg.wt.

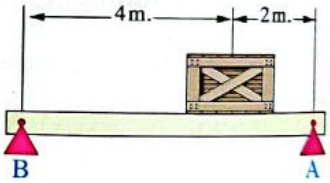
(a) $\frac{1}{15}\sqrt{3}$ (b) $\frac{1}{5}\sqrt{3}$ (c) $5\sqrt{3}$ (d) $15\sqrt{3}$

7 If the force $\vec{F} = 3\hat{i} - 4\hat{j} - 12\hat{k}$ acts at the point A (– 1 , 2 , 1) , then the moment of the force $\vec{F}$ with respect to the point B (3 , 4 , 0) = ...

(a) $28\hat{i} + 45\hat{j} + 22\hat{k}$ (b) $-20\hat{i} - 9\hat{j} - 2\hat{k}$

(c) $28\hat{i} - 51\hat{j} + 22\hat{k}$ (d) $28\hat{i} - 45\hat{j} + 22\hat{k}$

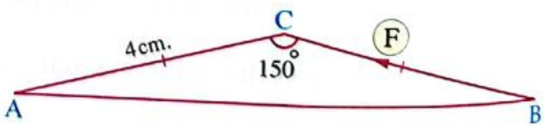
8 The opposite figure represents a box of weight 60 newton placed on a wooden board (neglected weight) , then the pressure acting on the supporter A in newton equals ....



(a) 10 (b) 20 (c) 25 (d) 40

9 **In the opposite figure :**

Δ ABC is an isosceles triangle in which BC = AC = 4 cm. , m (∠ C) = 150°



If the force $\vec{F}$ acts along $\overrightarrow{BC}$ where F = 15 newton , then the algebraic measure of the moment of the force $\vec{F}$ about A equals .... newton.cm.

(a) 60 (b) 30 (c) 120 (d) 15

10 ABCD is a rhombus of side length 12 cm. , m (∠ A) = 60° forces of magnitudes 50 , 80 , 50 , 80 gm.wt. act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{DA}$ respectively , if the system of forces is equivalent to a couple , then the magnitude of its moment = ... gm.wt.cm.

(a) $780\sqrt{3}$ (b) $480\sqrt{3}$ (c) $90\sqrt{3}$ (d) [illegible]$\sqrt{3}$

11 A thin wire of uniform thickness and density , it is bent in the form of a right-angled triangle at B in which AB = 3 cm. , BC = 4 cm. , then the distance between the centre of gravity of the wire and each of $\overline{BA}$, $\overline{BC}$ is ....

ⓐ (1.5 , 1) ⓑ (2 , 1.5) ⓒ $\left(\frac{8}{7} , \frac{9}{14}\right)$ ⓓ $\left(\frac{12}{7} , \frac{11}{14}\right)$

12 A uniform rod of weight (W) , it is connected at one of its ends with a hinge , and the other end is attached with a string fastened at a point in the same horizontal plane passing through the hinge such that the measure of the angle of inclination between each of the rod and the string with the horizon equals θ , then the reaction of the hinge = ...

ⓐ $\frac{1}{4} W\sqrt{9+\cot^2\theta}$ ⓑ $\frac{1}{4} W\sqrt{1+\cot^2\theta}$

ⓒ $W\sqrt{8+\csc^2\theta}$ ⓓ $\frac{1}{4} W(3+\cot\theta)$

13 A body of weight $\sqrt{57}$ kg.wt. is placed on a rough horizontal plane. Two forces of magnitudes 2 , 3 kg.wt. act on the body such that they include an angle of measure 60° between them and the two forces are horizontal and laying in the same horizontal plane of the body. If the body became about to move , then the static coefficient of friction between the body and the plane = ...

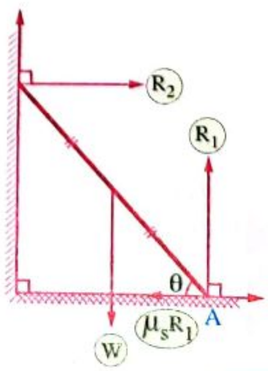
ⓐ $\sqrt{3}$ ⓑ $\frac{1}{\sqrt{3}}$ ⓒ $\frac{1}{3}$ ⓓ $\frac{1}{\sqrt{2}}$

14 $\overline{AB}$ is a non-uniform rod of length 24 cm. and of weight 10 newton it rests in horizontal state on two supporters at C and D where AC = BD = 5 cm. A weight of 20 newton is hanged at A , then the rod became about rotation about C , then the distance of the point of action of the rod's weight from A = ... cm.

ⓐ 10 ⓑ 20 ⓒ 9 ⓓ 15

15 **In the opposite figure :**

If λ is the measure of the angle of friction between the rod and the ground , then tan θ tan λ = ...



ⓐ 3 ⓑ 2

ⓒ 1 ⓓ $\frac{1}{2}$

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16 ABC is a thin lamina in the shape of a right-angled triangle at B , its weight = 6 newton act at the point of meeting of its medians , if AB = 12 cm. , BC = 15 cm.
It is suspended at a nail passing through a small hall at A such that its plane is vertical. A couple act on its plane to make it at rest when $\overline{AB}$ is vertical , then the magnitude of the moment of the couple = ... newton.cm.

(a) 15 (b) 30 (c) 45 (d) 60

---

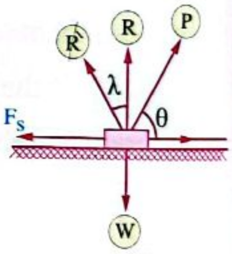
17 ABCD is a thin uniform lamina in the shape of a square of side length 48 cm. and its mass = 40 gm. L and M are the two midpoints of $\overline{AB}$ and $\overline{AD}$ respectively the triangle ALM is cut , then two masses each of them equal the mass of Δ ALM are fixed at the two points C and D and a mass equals twice the mass of the separated triangle is fixed at B
The system is suspended freely at the point C , then the tangent of inclination of $\overline{BC}$ with vertical in the equilibrium position = ...

(a) $\frac{25}{31}$ (b) 1 (c) $\frac{1}{2}$ (d) $\frac{31}{25}$

---

18 **In the opposite figure :**

If a body is in equilibrium on a rough horizontal plane
A force $\vec{P}$ inclined to the horizontal at an angle of measure θ
The friction is limiting at θ = 60° and λ = 30° , then all the following statements are true except ....



(a) $F_s = \frac{1}{2} P$ (b) $\grave{R} = P$ (c) $R = \frac{\sqrt{3}}{3} P$ (d) $W = \sqrt{3} P$

---

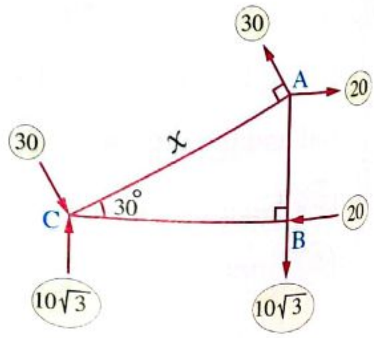
19 If $\vec{F_1}$, $\vec{F_2}$ are two forces acting at two points A , B respectively where $2\vec{F_1} = -3\vec{F_2}$ and their resultant acts at point $C \in \overleftrightarrow{AB}$, then ....

(a) AC : CB = 2 : 1
(b) AC : AB = 2 : 3
(c) BC : AC = 3 : 2
(d) BC : AB = 3 : 2

---

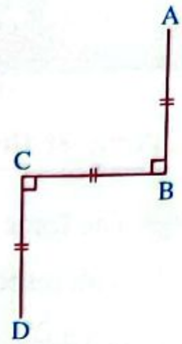
20 **In the opposite figure :**

If the algebraic measure of the moment of the resultant couple equals 100 N.cm. , then x = ... cm.



(a) 10
(b) 20
(c) 25
(d) 30

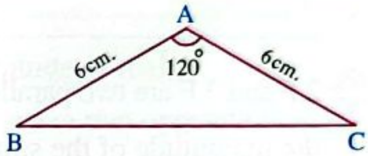
21 The opposite figure represents a uniform rod.
Its bent into three equal parts
, then the centre of rod lies at the ....



(a) midpoint of $\overline{AB}$
(b) midpoint of $\overline{BC}$
(c) midpoint of $\overline{CD}$
(d) point C

---

22 Which of the following sets of forces if they act along the sides of the triangle ABC and in one cyclic order they can produce a couple ?



(a) 10 , 10 , 10 newton.
(b) 6 , 8 , 10 newton.
(c) 12 , 12 , $12\sqrt{2}$ newton.
(d) 15 , 15 , $15\sqrt{3}$ newton.

---

23 $\overline{AB}$ is a uniform rod of weight 16 kg.wt. and of length 4.2 metres , C and D are two points on the rod where AC = 1.2 metre , BD = 0.6 metre the rod is hung from C and D by two strings $\overline{EC}$ and $\overline{OD}$. A force of magnitude $7\frac{1}{2}$ kg.wt. acted on the rod in the direction $\overrightarrow{AB}$ to make the string $\overline{OD}$ in vertical position and the string $\overline{EC}$ inclined to the horizon , then the rod becomes in equilibrium in horizontal position , then the inclination of $\overline{EC}$ to the horizon = ...

(a) $\frac{1}{2}$
(b) $\frac{1}{3}$
(c) $\frac{3}{4}$
(d) $\frac{4}{3}$

---

24 **In the opposite figure :**
A system consists of two bodies , their masses are 2 kg. , 4 kg. placed at A and B. If the mass 4 kg. has been moved in $\overrightarrow{AB}$ direction 5 cm. so in order not to change the position of the centre of gravity of the system the mass 2 kg. should move ....

(a) 2.5 cm. in $\overrightarrow{AB}$ direction.
(b) 2.5 cm. in $\overrightarrow{BA}$ direction.
(c) 10 cm. in $\overrightarrow{AB}$ direction.
(d) 10 cm. in $\overrightarrow{BA}$ direction.

---

25 Two parallel forces acting in the same direction, their magnitudes are F , 3 F and acting at two points A , B respectively. If the two forces switched their places , then their resultant moves a distance equals .... length unit.

(a) $\frac{3}{4}$ AB
(b) $\frac{1}{2}$ AB
(c) $\frac{1}{3}$ AB
(d) $\frac{1}{4}$ AB

Answer the following questions :

1. The force $\vec{F} = 3\hat{i} + \hat{j}$ acts at the point A (2 , – 1) , then the vector moment of this force with respect to the point B (1 , 2) equals ....

(a) $7\hat{k}$ (b) $-10\hat{k}$ (c) $10\hat{k}$ (d) $-7\hat{k}$

---

2. 2 F and 3 F are two parallel forces act in the same direction , their resultant = 35 newton , then the magnitude of the smaller force in newton equals ....

(a) 7 (b) 10 (c) 14 (d) 21

---

3. ABCD is a parallelogram in which AB = 6 cm. , BC = 8 cm. , m (∠ A) = 60°
, forces of magnitudes 8 , 10 , 8 , 10 newton act along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$, $\overrightarrow{AD}$ respectively.
, then the magnitude of the moment of the couple which is equivalent to this system = ... newton.cm.

(a) $2\sqrt{3}$ (b) $4\sqrt{3}$
(c) $62\sqrt{3}$ (d) $30\sqrt{3}$

---

4. ABCD is a right trapezium at B , $\overline{AD} // \overline{BC}$, AB = 8 cm. , BC = 15 cm. , AD = 9 cm.
Forces of magnitudes F , 44 , 68 gm.wt. act along $\overrightarrow{DA}$, $\overrightarrow{DC}$, $\overrightarrow{AC}$ respectively.
If the line of action of the resultant of this system passes through the point B
, then the value of F equals .... gm.wt.

(a) 114 (b) 126
(c) 156 (d) 184

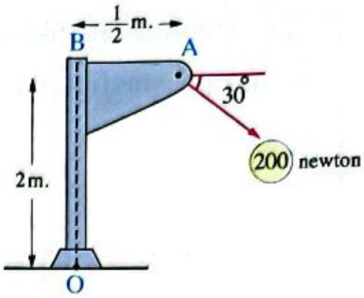
---

5. The distance between the centre of gravity of two bodies whose masses are 3 and 5 kg. and the distance between them = 8 metre from the first body in metre equals ....

(a) 2 (b) 3
(c) 4 (d) 5

6 **In the opposite figure :**

The algebraic measure of moment of the force whose magnitude = 200 newton with respect to the point O equals .... N.metre.



(a) $-200\sqrt{3}$ (b) -50

(c) $-250\sqrt{3}$ (d) $-200\sqrt{3}-50$

---

7 Two parallel forces of magnitudes 15 and F newton. If the magnitude of their resultant = 25 newton and given that the force and the resultant are in two opposite directions , then the value of the force F in newton = ...

(a) 10 (b) 20 (c) 30 (d) 40

---

8 $\overline{AB}$ is a uniform rod of length 260 cm. and of weight 43 newton rests at its end A on a vertical wall and at its end B on a horizontal ground. The two coefficients of static friction between the rod and each of the wall and the ground equal $\frac{1}{4}$ and $\frac{1}{2}$ respectively. The end B is at a distance 100 cm. from the wall , then the magnitude of the horizontal force which acts at B to make the rod about to move towards the wall = ... newton.

(a) 32.75 (b) 45.5 (c) 22.75 (d) 55.5

---

9 If the two forces $\overrightarrow{F_1} = 4\hat{i} + a\hat{j} + 5\hat{k}$, $\overrightarrow{F_2} = b\hat{i} - 7\hat{j} + c\hat{k}$ form a couple , then a + b + c = ...

(a) -16 (b) -2 (c) 2 (d) 16

---

10 A body of weight 50 newton is placed on an inclined rough plane , which makes with the horizon an angle of measure θ. If the least force and greatest force which act parallel to the line of greatest slope to make the body in equilibrium on the plane are 10 and 40 newton respectively , then the coefficient of static friction = ...

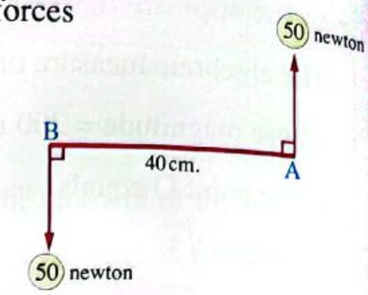
(a) $\frac{1}{2}$ (b) $\frac{\sqrt{3}}{5}$ (c) $\frac{\sqrt{3}}{6}$ (d) $\frac{1}{5}$

---

11 If $\overrightarrow{F} = 3\hat{i} + 4\hat{j}$ acts at the point A (− 1 , 3) of a body , then the length of the perpendicular drawn from O to the line of action of the force $\overrightarrow{F}$ = ... length unit.

(a) 2.6 (b) 0.52 (c) 1.3 (d) 2

12 The algebraic measure of moment of the couple of the shown forces in the opposite figure in newton.m. equals ....

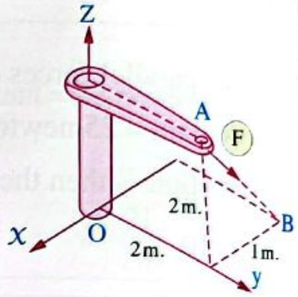


(a) – 20 (b) – 2000
(c) 20 (d) 2000

13 **In the opposite figure :**

The moment of the force

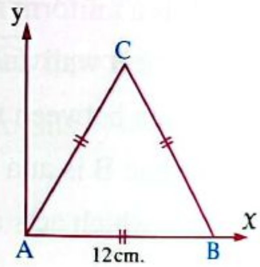
$F = 14\sqrt{5}$ newton about the point O equals ....



(a) $-56\hat{i} - 28\hat{j} + 28\hat{k}$ (b) $-56\hat{i} + 28\hat{j} - 28\hat{k}$
(c) $-56\hat{i} - 28\hat{j} - 28\hat{k}$ (d) $-14\hat{i} - 28\hat{j}$

14 The centre of gravity of the following system is ....

The mass	4 gm.	5 gm.	3 gm.
The position	at A	at B	at C



(a) $\left(6\frac{1}{2}, \frac{3}{2}\sqrt{3}\right)$ (b) $\left(6\frac{1}{2}, 6\sqrt{3}\right)$
(c) $\left(6\frac{1}{2}, \frac{5}{3}\sqrt{3}\right)$ (d) $\left(9, 3\sqrt{3}\right)$

15 A rod $\overline{AB}$ of length 60 cm. and weight 400 gm.wt. acting at its midpoint , rests on a support at a distance 20 cm. from A. It is kept in equilibrium horizontally by a vertical light string connecting at B , then the magnitude of the weight needed to be hanged at the end A to make the tension in the string about to vanish = ... gm.wt.

(a) 200 (b) 400 (c) 20 (d) 300

16 ABCD is a thin uniform lamina in the shape of a square of side length 20 cm. and of weight 200 gm.wt. acting at its geometrical centre. It is suspended by a nail passing through a small hole near by A such that its plane is vertical. A couple with moment of magnitude 1000 gm.wt.cm. acts on the lamina in a perpendicular direction to its plane to be in equilibrium , then the sine of the angle of inclination of $\overline{AC}$ to the vertical = ...

(a) $\frac{1}{\sqrt{2}}$ (b) $\frac{\sqrt{2}}{4}$ (c) $\frac{1}{\sqrt{7}}$ (d) $\frac{1}{2}$

17. $\overline{AC}$ is a uniform rod of length 2ℓ. It is bent at its midpoint then it is suspended from the end A freely. If $\overline{BC}$ is horizontal in equilibrium position , then $\cos(\angle ABC) =$ ....

(a) $\frac{1}{4}$ (b) $\frac{1}{3}$ (c) $\frac{1}{8}$ (d) $\frac{1}{2}$

18. A thin uniform lamina in the shape of the square ABCD of side length 48 cm. M is the point of intersecting of its diagonals , then Δ CMD is cut to be fixed on the triangle CMB such that $\overline{MD}$ coincides $\overline{MB}$, then the distance between the centre of gravity of the lamina and the point B = ... cm.

(a) 20 (b) 40 (c) $20\sqrt{2}$ (d) $40\sqrt{2}$

19. A body of weight 10 N. is placed on a rough plane inclined to the horizontal at an angle of measure θ , the body is about to move under action of its weight only. If another body made of the same material and of weight 20 N. is placed on the same inclined plane , then the second body will ....

(a) be about to move down.

(b) be in equilibrium but it is not about to move.

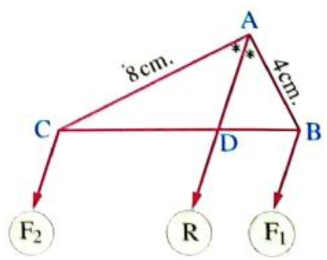
(c) slide downward.

(d) be about to move up.

20. A rod is hinged to a vertical wall , X_1 and Y_1 are the algebraic components of the reaction of the hinge and if $X_1 = a$ kg.wt. , $Y_1 = a\sqrt{3}$ kg.wt. and $\vec{R} = 10$ kg.wt. , then a = ...

(a) 3 (b) 4 (c) 5 (d) 10

21. **In the opposite figure :**



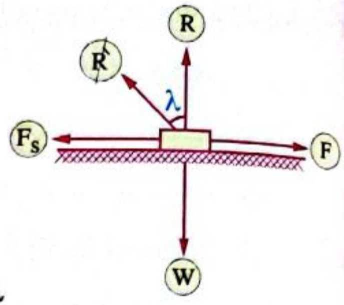
If $\overrightarrow{AD}$ bisects $\angle$ A and F_1 , F_2 are two parallel forces acting at B and C. Their resultant acts at D , then $F_1 =$ ....

(a) F_2 (b) $\frac{1}{2} F_2$

(c) $2 F_2$ (d) $\frac{1}{3} F_2$

22 In the opposite figure :

If the friction is limiting and the coefficient of static friction between the body and the plane is μ_s , then all the following statements are true except ....



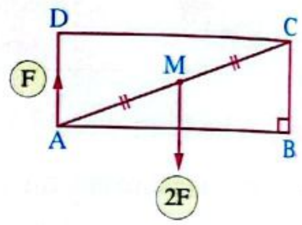
(a) $\grave{R} = \sqrt{1 + \mu_s^2}$ (b) $W = \grave{R} \cos \lambda$

(c) $\mu_s R = \grave{R} \sin \lambda$ (d) $R = \grave{R} \cos \lambda$

---

23 In the opposite figure :

ABCD is a rectangle. F , 2 F are two parallel forces act as shown in the figure, then the line of action of resultant is ....



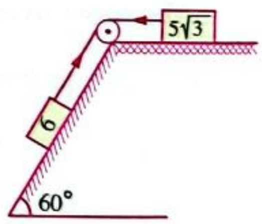
(a) $\overleftrightarrow{AD}$ (b) $\overleftrightarrow{CB}$

(c) $\overleftrightarrow{AC}$ (d) $\overleftrightarrow{DC}$

---

24 In the opposite figure :

A body of weight 6 N. is placed on a smooth inclined plane makes an angle of measure 60° with the horizontal.
A body of weight $5\sqrt{3}$ N. is placed on a rough horizontal plane.



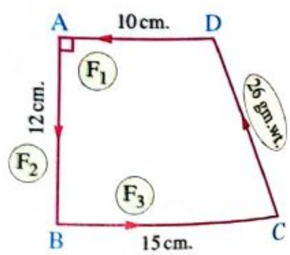
The two bodies are connected by a string passes over a smooth pulley and they were about to move , then the coefficient of static friction between the body $5\sqrt{3}$ N. and the rough plane equals ....

(a) $\frac{1}{2}$ (b) $\frac{5}{6}\sqrt{3}$ (c) $\frac{3}{5}$ (d) $\frac{5}{3}$

---

25 In the opposite figure :

ABCD is a right-angled trapezium at A , the forces shown in the figure are represented by the sides of the trapezium completely if the system is equivalent to a couple , then $F_1 + F_2 + F_3 =$ .... gm.wt.



(a) 74 (b) 30 (c) 24 (d) 20

Answer the following questions :

1. If the limiting force of friction = 30 newton and the magnitude of the resultant reaction = 50 newton , then the coefficient of static friction equals ....

(a) $\frac{9}{16}$ (b) $\frac{3}{4}$ (c) $\frac{4}{5}$ (d) $\frac{4}{3}$

2. If $\overrightarrow{F_1} // \overrightarrow{F_2}$ and in the same direction where $F_1 = 50$ gm.wt. , $F_2 = 60$ gm.wt. , the distance between them = 44 cm. , then the distance between $\overrightarrow{R}$ and $\overrightarrow{F_1}$ = ... cm.

(a) 16 (b) 18 (c) 20 (d) 24

3. If $\overrightarrow{M_1}$ and $\overrightarrow{M_2}$ are two equilibrium couples and $\overrightarrow{M_1} = 20\,\hat{k}$, then $\overrightarrow{M_1} - \overrightarrow{M_2}$ = ...

(a) $40\,\hat{k}$ (b) $\vec{0}$ (c) 0 (d) $-40\,\hat{k}$

4. A uniform rod of weight (W) rests at one of its ends on a vertical rough wall and the other end on a rough horizontal ground , the coefficient of static friction between the rod and the wall = $\frac{1}{4}$ and the coefficient of static friction between the rod and the ground = $\frac{1}{3}$, if the rod in equilibrium be in a vertical plane perpendicular to the wall , then the tangent of the angle of inclination of the rod with the vertical when the rod is about to slide = ...

(a) $\frac{11}{8}$ (b) $\frac{8}{11}$ (c) $\frac{8}{13}$ (d) $\frac{11}{13}$

5. Three equal forces in magnitude are parallel and act at the vertices of the triangle ABC in the same direction , then their resultant acts at ....

(a) the centre of the circumcircle of the triangle.
(b) the point of intersection of the medians of the triangle.
(c) the point of intersection of the altitudes of the triangle.
(d) the point of intersection of the bisectors of the internal angles of the triangle.

6. The centre of gravity of two bodies of masses 3 kg. and 6 kg. and the distance between them equals 15 cm. is at a distance from the first body equals .... cm.

(a) 4 (b) 5 (c) 7.5 (d) 10

7 If the force $\overrightarrow{F} = 2\hat{i} + b\hat{j} + \hat{k}$ acts at the point A (– 1 , 3 , – 2) and the component of the moment of $\overrightarrow{F}$ about X-axis equals – 3 moment unit , then b = ...

(a) – 3 (b) 3 (c) zero (d) – 6

8 If $\overrightarrow{F} = 3\hat{i} - 4\hat{j}$ acts at the point A (0 , 2) and if C = (2 , 3) , E = (5 , – 1) , then the line of action of the force $\overrightarrow{F}$ ....

(a) paralles $\overleftrightarrow{CE}$ (b) paralles $\overleftrightarrow{AE}$ (c) bisects $\overline{CE}$ (d) bisects $\overline{AC}$

9 ABC is an equilateral triangle of side length 12 cm. A force of magnitude 20 newton acts along $\overrightarrow{BC}$, then the magnitude of the moment of this force with respect to the point A is .... newton.cm.

(a) $120\sqrt{3}$ (b) 240 (c) 120 (d) $12\sqrt{3}$

10 If A , B and C are three non-collinear points where a set of forces act in its plane such that it forms a couple and it is found that $2 M_A + 3 M_B + 5 M_C = 120$ newton.cm.
, then $3 M_A - M_C =$ .... newton.cm.

(a) 12 (b) 24 (c) 36 (d) zero

11 Two parallel forces of magnitudes 3 and 4 kg.wt. act at the two points A and B respectively in the same direction. If the first force is displaced such that it is parallel to itself , a distance ℓ on the ray $\overrightarrow{BA}$, then the resultant of these two forces displaced a distance = ... cm. in the same direction.

(a) $\frac{1}{7}\ell$ (b) $\frac{3}{7}\ell$ (c) $\frac{2}{7}\ell$ (d) $\frac{1}{4}\ell$

12 If $\overrightarrow{F_1} = 6\hat{i} + 3\hat{j}$ acts at the point A (1 , – 3) and $\overrightarrow{F_2} = -\hat{i} - 4\hat{j}$ acts at the point B (2 , 5) and $\overrightarrow{F_3} = \hat{j} - 5\hat{i}$ acts at the point C (4 , – 1) , if this system form a couple , then the magnitude of its moment = ... moment unit.

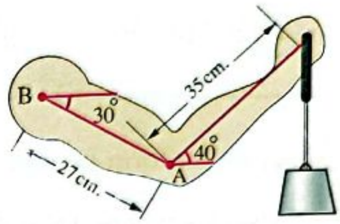
(a) 17 (b) 25 (c) – 17 (d) – 25

13. ABCDEF is a regular hexagon of side length 15 cm. forces of magnitudes 40 , 50 , 30 , 40 , 50 , 30 newton act along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$, $\overrightarrow{DE}$, $\overrightarrow{FE}$, $\overrightarrow{FA}$ respectively , then the magnitude of the moment of the resultant couple = ... newton.cm.

(a) $450\sqrt{3}$ (b) $1500\sqrt{3}$ (c) $750\sqrt{3}$ (d) $300\sqrt{3}$

---

14. The opposite figure represents a person carrying with his hand a weight. If the moment of the weight about A = 80 newton. metre , then the norm of the moment of the weight about B ≃ .... newton.metre.



(a) 140 (b) 150 (c) 180 (d) 210

---

15. If three equal masses are placed at the vertices of Δ ABC where A (2 , 1) , B (3 , 4) , C (4 , 1) , then the centre of gravity of this system is ....

(a) (2 , 3) (b) (3 , 2) (c) (6 , 9) (d) (9 , 6)

---

16. A body of weight 200 gm.wt. is placed on a rough plane inclining with the horizon with an angle whose sine = $\frac{1}{2}$, the coefficient of static friction between the body and the plane = $\frac{\sqrt{3}}{6}$. A force whose magnitude 75 gm.wt. acts in the direction of the greatest line slope upwards. If the body is at rest , then the force of friction = ... gm.wt.

(a) 100 (b) 25 (c) 75 (d) 50

---

17. $\overline{AB}$ is a non-uniform rod of length 120 cm. rests in a horizontal position on two supporters at C and D of the rod where AC = 30 cm. , BD = 40 cm. If a weight of magnitude 160 gm.wt. is suspended at A , then the rod will be about to rotate about C and if a weight of magnitude 500 gm.wt. is suspended at B without removing that at A , then the rod will be about to rotate about D , then the weight of the rod = ... gm.wt.

(a) 240 (b) 120 (c) 360 (d) 480

18 ABCD is a thin lamina in the shape of a square of side length 50 cm. and of weight 300 gm.wt. acting at the centre of the square. The lamina is suspended at a small hole near by the vertex A by a horizontal nail such that its plane is vertical. A couple of algebraic measure of moment = 7500 gm.wt.cm. act on the lamina , then the measure of angle of inclination of the diagonal $\overline{AC}$ with the vertical in the equilibrium position = ...

(a) 30° or 150° (b) 45° or 135° (c) 60° or 120° (d) 90°

---

19 A thin uniform lamina in thickness and density in the form of a triangle ABC which is isosceles where AB = AC = 26 cm. , BC = 20 cm. $\overleftrightarrow{AD}$ is drawn to be perpendicular to $\overline{BC}$ which cuts it at D. If E is the midpoint of $\overline{AD}$. The Δ EBC is separated , then the distance between the centre of gravity of the remained part from the point E = ... cm.

(a) 10 (b) 12 (c) zero (d) $2\sqrt{61}$

---

20 If $\overrightarrow{F_1}$ acts at point A , $\overrightarrow{F_2}$ acts at point B , $\overrightarrow{F_2} + 3\overrightarrow{F_1} = \overrightarrow{O}$ and their resultant acts at point C where $C \in \overleftrightarrow{AB}$, then AB + AC = ...

(a) 3 BC (b) 4 BC (c) 5 BC (d) 6 BC

---

21 A 4 kg. body is placed on a rough inclined plane makes an angle of measure 30° with the horizontal and the coefficient of friction between the body and the plane is $\frac{\sqrt{3}}{2}$ the body ....

(a) is about to move up the plane.
(b) is about to move down the plane.
(c) moves on the plane.
(d) remains at rest.

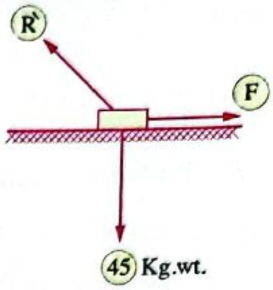
---

22 The distance between the centre of gravity of a lamina of uniform thickness and density in form of a uniform hexagon , its side length is 6 cm. , from one of its vertices equals .... cm.

(a) 12 (b) 6 (c) 4 (d) 3

23 **In the opposite figure :**

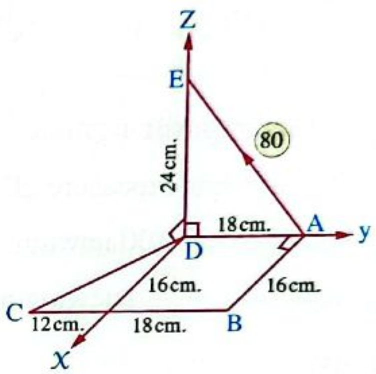
A body of weight 45 kg.wt. is placed on a rough horizontal plane. The coefficient of static friction between the body and the plane $= \frac{\sqrt{3}}{3}$ If the body is about to move , then $F + \grave{R} =$ .... kg.wt.



(a) 45
(b) $45\sqrt{3}$
(c) $30\sqrt{3}$
(d) $15\sqrt{3}$

---

24 ABCD is a right trapezium at $\angle B$, $\overline{AD} \parallel \overline{BC}$, AB = 16 cm. , BC = 30 cm. , AD = 18 cm. Draw $\overline{DE} \perp$ the plane of the trapezium where DE = 24 cm. Force of magnitude 80 newton acts in the direction of $\overrightarrow{AE}$, then the magnitude of the moment of the force about B = ... newtons.cm.



(a) 768
(b) 1024
(c) 1280
(d) 1486

---

25 $\overline{AB}$ is a light fine rod of length 2ℓ connected in a vertical plane at its two ends A , B by two strings inclined at 30° , 60° to the vertical respectively , two weights of 2 , 8 newtons are suspended on the rod distant $\frac{1}{5}\ell$, $\frac{6}{5}\ell$ from A , then in the case of equilibrium , the measure of the angle of inclination of the rod to the horizontal = ...°

(a) 15
(b) 30
(c) 45
(d) 60

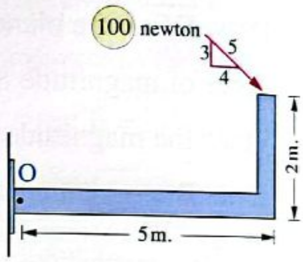
Answer the following questions :

1 A body of weight 240 kg.wt. , placed on a horizontal rough plane. It is wanted to be pulled by a string making with the horizon an angle of measure 30° upwards. If the static coefficient friction equals 0.3 , then the magnitude of tension which is needed to make the body about to move ≃ .... kg.wt.

(a) 70.86 (b) 72 (c) $24\sqrt{3}$ (d) 100.56

2 In the opposite figure :

The algebraic measure of the moment of the force whose magnitude = 100 newton about the point O equals .... newton.m.

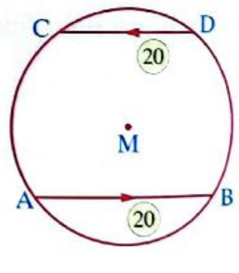


(a) – 160 (b) – 460

(c) – 300 (d) 450

3 In the opposite figure :

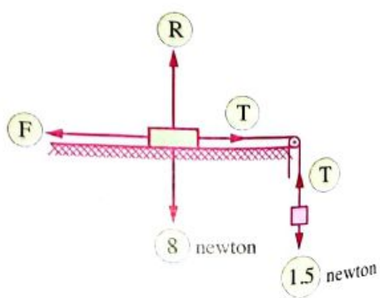
Two forces each of them is of magnitude 20 kg.wt. , DC = 12 cm. , BA = 16 cm. , the radius length of the circle = 10 cm. , then the algebraic measure of the moment of the couple equals .... kg.wt. cm.



(a) 280 (b) 320 (c) 120 (d) 240

4 In the opposite figure :

If the coefficient of static friction = $\frac{1}{4}$, then ....



(a) the body is about to move.

(b) the body moves on the plane.

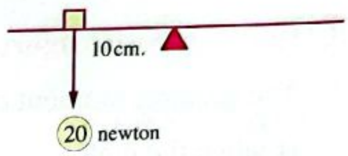
(c) the friction between the body and the plane is limiting.

(d) the friction between the body and the plane is not limiting.

5. If the force $\overrightarrow{F} = 2\hat{i} + 3\hat{j} - \hat{k}$ acts at the point A (1 , – 1 , 4) , then the length of the perpendicular drawn from B (2 , – 3 , 1) on the line of action of the force = ... length unit.

(a) 3.73 (b) 13.96 (c) 37.3 (d) 0.27

6. **In the opposite figure :**



A uniform rod rests on a supporter at its midpoint.

A body is placed on it as shown in the figure. Which of the following forces makes the rod in equilibrium ?

(a) A force of magnitude 10 newton upwards acts at a distance 20 cm. at the right side of the midpoint of the rod.

(b) A force of magnitude 10 newton downwards acts at a distance 20 cm. at the right side of the midpoint of the rod.

(c) A force of magnitude 30 newton downwards acts at a distance 5 cm. at the left side of the midpoint of the rod.

(d) A force of magnitude 30 newton upwards acts at a distance 5 cm. at the left side of the midpoint of the rod.

7. $\overline{AB}$ is a uniform rod of length 60 cm. and of weight 8 newton is connected with a hinge fixed on its end A at a vertical wall. A weight equals 6 newton is suspended from a point of the rod at a distance 40 cm. from the end A , then the rod is in equilibrium horizontally by a light string attached from one of its terminals at B and the other terminal of the string is fixed at a point on the wall at a distance 80 cm. vertically up the point A , then the reaction of the hinge = ... newton.

(a) 6 (b) $6\sqrt{2}$ (c) 12 (d) 10

8. The centre of gravity of the system formed from $m_1 = 1$ at (2 , 3) , $m_2 = 2$ at (– 2 , 1) , $m_3 = 3$ at (0 , 1) is the point ....

(a) $\left(-\frac{1}{3} , \frac{4}{3}\right)$ (b) $\left(\frac{7}{6} , \frac{4}{3}\right)$

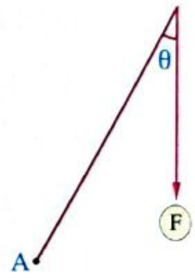
(c) $\left(-\frac{1}{3} , \frac{2}{3}\right)$ (d) (0 , 1)

9 A body of weight 200 gm.wt. is placed on a rough inclined plane. A force F acts on it in the direction of the line of the greatest slope upwards. If the body is about to move downwards when F = 80 gm.wt. and the body will be about to move upwards when F = 120 gm.wt. , then the measure of the angle of inclination of the plane with the horizon equals ....

(a) $22\frac{1}{2}^{\circ}$ (b) 30° (c) 45° (d) 60°

10 **In the opposite figure :**

The greatest moment of the force F about the point A is when θ equals ....



(a) zero (b) $\frac{\pi}{2}$

(c) π (d) 2π

11 A , B , C , D lie on one horizontal straight line such that AB = 5 cm. , BC = 10 cm. , CD = 15 cm. Forces of magnitudes 4 , 6 , 2 , 8 kg.wt. act at the points A , B , C and D vertically downwards respectively , then the distance between the point of action of the resultant from the point A = ... cm.

(a) 15 (b) 20 (c) 5 (d) 10

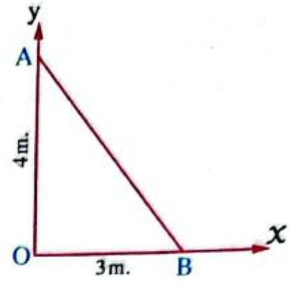
12 Two parallel forces , the small of them is of magnitude 30 newton and acts at the end A from a light rod $\overline{AB}$ and the great force acts at the other end B , if the magnitude of their resultant is 10 newton and acts at a distance 90 cm. from the end B , then the length of the rod = ... cm.

(a) 20 (b) 120 (c) 30 (d) 60

13 ABC is a lamina in the shape of an isosceles triangle in which AB = AC = 13 cm. , BC = 10 cm. It can rotate easily in a vertical plane about a hinge fixed at A If a couple of moment 200 gm.wt.cm. in magnitude acts on the lamina to be equilibrium when one of the two legs of the triangle is vertical , then the weight of the lamina given that it acts at the point of intersecting of the medians of the triangle = ... gm.wt.

(a) 75 (b) 65 (c) $\frac{325}{12}$ (d) [illegible]

14 In the opposite figure :



The force $\overrightarrow{F}$ acts in the plane of the triangle AOB

If the moment of $\overrightarrow{F}$ with respect to the point O = 84 newton.metre.

and its moment with respect to the point A = – 100 newton. metre.

and its moment with respect to the point B = zero

, then the magnitude of $\overrightarrow{F}$ = ... newton. and inclined with an angle of measure .... on $\overrightarrow{OX}$

(a) 54 , 31° 20̀ (b) 54 , 148° 40̀ (c) 16 , 31° 20̀ (d) 16 , 148° 40̀

---

15 ABCD is a trapezium in which $\overline{AD} // \overline{BC}$, m (∠ ABC) = 90° , AB = 8 cm. , BC = 17 cm. , AD = 11 cm. Forces of magnitude 22 , 16 , 34 , 20 gm.wt. act along $\overrightarrow{DA}$, $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$ respectively , if the system is equivalent to a couple , then the magnitude of its moment = ... gm.wt.cm.

(a) 224 (b) 448 (c) 896 (d) 112

---

16 Five equal masses are placed at the points A , B , C , D , E where ABCD is a square , E is the point of intersection of its diagonals and the length of its side is 12 cm. , then the distance between the centre of gravity of this system and the point A = ... cm.

(a) 6 (b) 12 (c) $12\sqrt{2}$ (d) $6\sqrt{2}$

---

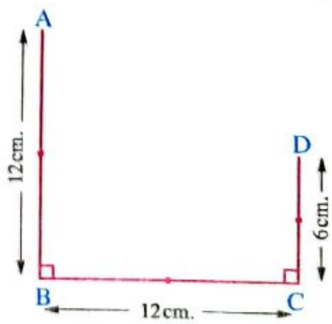
17 If the forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$, $\overrightarrow{F_3}$ act at the points (0 , 0) , (1 , 0) , (0 , 1) and they are equivalent to a couple where $\overrightarrow{F_1} = 3\hat{i} + 4\hat{j}$, $\overrightarrow{F_2} = -\hat{i} + \hat{j}$, then the magnitude of the couple equals .... moment unit.

(a) 2 (b) 4 (c) – 2 (d) 3

---

18 In the opposite figure :

$\overline{AD}$ is a wire of uniform thickness and density. It is bent at B and C , then the measure of inclination of $\overline{AB}$ to the vertical if the wire is hanged freely from A = ...



(a) 28° 4̀ (b) 21° 48̀ (c) 32° (d) 57° 59̀

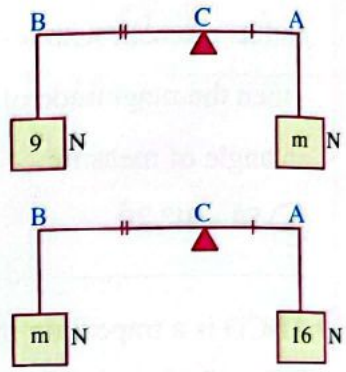
19 If $\overrightarrow{F_1} = -2\hat{i} + \hat{j}$ acts at A (– 2 , 0) , $\overrightarrow{F_2} \,/\!/\, \overrightarrow{F_1}$ where $\overrightarrow{R} = 6\hat{i} - 3\hat{j}$ acts at C (6 , 0)

, then the intersection point between the line of action of $\overrightarrow{F_2}$ and $\overleftrightarrow{AC}$ is ....

(a) (4 , 0) (b) (8 , 0) (c) (2 , 0) (d) (0 , 0)

---

20 **In the opposite figure :**



If both systems are in equilibrium

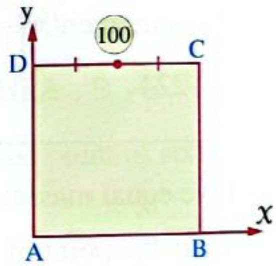
, then AC : CB = ... : ....

(a) 9 : 16 (b) 3 : 4

(c) 16 : 9 (d) 4 : 3

---

21 **In the opposite figure :**



A lamina of uniform thickness and density of mass 400 gm. in form of a square ABCD. Its side length 16 cm. A 100 gm. mass has been attached to the lamina at the midpoint of $\overline{CD}$

, then the centre of gravity of the system with respect to the axes $\overrightarrow{Ax}$, $\overrightarrow{Ay}$ is ....

(a) (9.6 , 9.6) (b) (8 , 9.6) (c) (8 , 16) (d) (8 , 12)

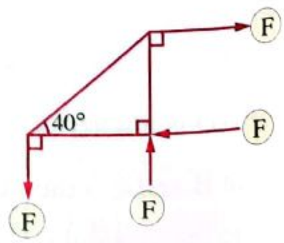
---

22 A body of weight 40 kg.wt. is placed on a horizontal rough plane , two perpendicular forces of magnitudes 6 and 8 kg.wt. acted horizontally on the body , the body stayed in equilibrium and μ_s is the coefficient of static friction , then ....

(a) $\mu_s \le \frac{1}{4}$ (b) $\mu_s \ge \frac{1}{4}$ (c) $\mu_s < \frac{1}{4}$ (d) $\mu_s = \frac{1}{4}$

---

23 The set of forces given in the opposite figure ....



(a) are in equilibrium.

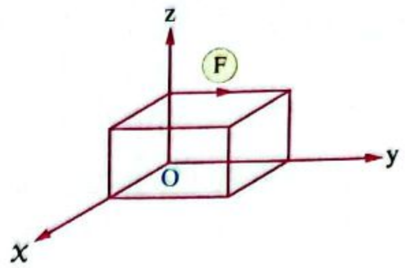
(b) equivalent to a force.

(c) equivalent to a couple the algebraic measure of its moment is positive.

(d) equivalent to a couple the algebraic measure of its moment is negative.

24 **In the opposite figure :**

The moment of the force $\vec{F}$ vanishes about ....



(a) the x-axis only.

(b) both the y-axis and z-axis.

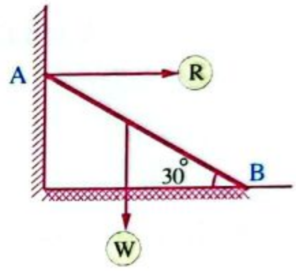
(c) both the x-axis and z-axis.

(d) the origin.

---

25 **In the opposie figure :**

$\overline{AB}$ is a uniform ladder of weight (w) rest with its upper end A against a smooth vertical wall and its lower end B on a rough horizontal ground and the measure of inclination of the ladder to the ground is 30°



If the ladder is in equilibrium and the reaction at A equals $8\sqrt{3}$, then the normal reaction at B equals .... newton.

(a) $16\sqrt{3}$ (b) $8\sqrt{3}$ (c) 8 (d) 16

Answer the following questions :

1. If the force $\overrightarrow{F} = \hat{i} - 2\hat{j}$ acts at the point A (2 , 3) , then the length of the perpendicular drawn from the point B (2 , 1) on the line of action of the force = ... length unit.

(a) $\frac{\sqrt{5}}{2}$ (b) $\frac{\sqrt{5}}{5}$ (c) $\frac{2\sqrt{5}}{5}$ (d) $\frac{\sqrt{2}}{5}$

2. Two parallel forces act in the same direction , their magnitudes are F and 3 F act at the two points A and B respectively where AB = 60 cm. , then the resultant act at the point C where AC = ... cm.

(a) 36 (b) 40 (c) 45 (d) 50

3. If the two forces $\overrightarrow{F_1} = 5\hat{i} + a\hat{j} + 3\hat{k}$, $\overrightarrow{F_2} = b\hat{i} - 9\hat{j} + c\hat{k}$ form a couple , then a + b + c = ...

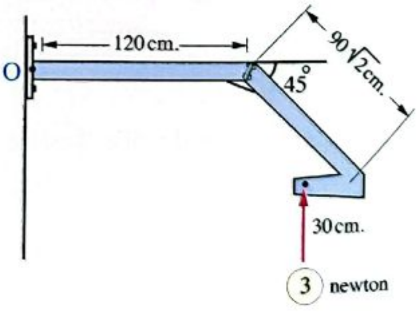
(a) -1 (b) 1 (c) 8 (d) 17

4. If the angle of friction is λ , R is the normal reaction , then the resultant reaction $\grave{R}$ = ...

(a) $R\sqrt{1+\tan\lambda}$ (b) $R\tan\lambda$ (c) $R\sqrt{1+\sec\lambda}$ (d) $R\sec\lambda$

5. **In the opposite figure :**

The algebraic measure of moment of the force whose magnitude = 3 newton. with respect to the point O equals .... newton.cm.



(a) 630

(b) 720

(c) 450

(d) 540

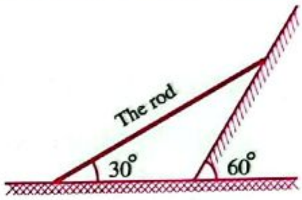
6. A body of weight 21 newton is placed on a horizontal rough plane. Two horizontal forces of magnitudes 3 and 5 newton act on the body where they include an angle on measure 60° between them , then the body became about to move , then the static coefficient of friction equals ....

(a) 3 (b) $\frac{1}{3}$ (c) 7 (d) $\frac{1}{7}$

7 A , B , C , D and E are collinear points , lie on one horizontal straight line such that AB = 2 BC = CD = 2 DE = 10 cm. forces of magnitudes 3 , 5 , 4 kg.wt. act vertically upwards at the points A , C , E and the forces of magnitudes 6 and 10 kg.wt. act vertically downwards at the two points B and D , then the distance of the point of action of the resultant from the point E = ... cm.

(a) 1.25 (b) 2.5 (c) 6.25 (d) 28.75

8 **In the opposite figure :**



A uniform rod of weight 24 kg.wt. rests with one of its ends on a horizontal ground and with the other end on a smooth plane inclining with the horizon with an angle of measure 60°

If the rod is about to slide when it makes with the horizon an angle of measure 30° , then the reacion of the ground = ... kg.wt.

(a) 12 (b) $6\sqrt{3}$ (c) $18\sqrt{3}$ (d) $12\sqrt{3}$

9 ABC is a right-angled triangle at A where AB = AC = 5 cm. forces of magnitudes 40 , 40 , $40\sqrt{2}$ newton act along $\overrightarrow{BA}$, $\overrightarrow{AC}$, $\overrightarrow{CB}$ respectively. If two forces F , F act at the points B and C perpendicular to $\overline{BC}$ in order that the system will be in equilibrium , then F = ... newton.

(a) $20\sqrt{2}$ (b) $40\sqrt{2}$ (c) $5\sqrt{2}$ (d) 20

10 A uniform rod of length 64 cm. and weight 70 newton rests horizontally on two supports one of them is at a distance 8 cm. from one of the two ends and the other is at a distance 14 cm. from the other end , then the weight that will be suspended from the other end so that the rod will be about over turning = ... newton.

(a) 180 (b) 45 (c) 90 (d) 160

11 A body of weight 14 kg.wt. is placed on a horizontal rough plane , when the body is pulled with a horizontal force of magnitude 7 kg.wt. , then the body will be about to move. If a weight of magnitude 6 kg.wt. is placed on the body , then the magnitude of the horizontal force which act on the body to make it and the weight about to move = ...

(a) 98 newton. (b) 10 newton. (c) 20 kg.wt. (d) 5 kg.wt.

12 ABCDEF is a regular hexagon of side length 4 cm. Forces of magnitudes 1 , 3 , 5 , 2 , 4 and 6 newton act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{DE}$, $\overrightarrow{EF}$, $\overrightarrow{AF}$ respectively , then the magnitude of the algebraic sum of the moments of these forces about the centre of the hexagon (M) equals .... newton.cm.

(a) $\sqrt{3}$ (b) $2\sqrt{3}$

(c) $4\sqrt{3}$ (d) $8\sqrt{3}$

---

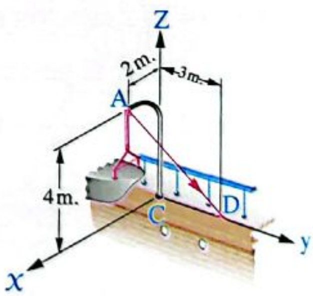
13 A body of weight 8 kg.wt. is placed on a horizontal rough plane then the plane is inclined gradually till the body became about to slide downwards the plane when the measure of the angle of inclination of the plane with the horizon is 30°. If the body is connected with a string , then it is pulled in a direction making an angle of measure 30° with the plane till the body became about to move upwards , then the magnitude of the normal reaction = ... kg.wt.

(a) $4\sqrt{3}$ (b) $6\sqrt{3}$

(c) $8\sqrt{3}$ (d) $2\sqrt{3}$

---

14 **In the opposite figure :**



A rope fixed at the point D passes over a smooth pulley at A and a small boat is hanged at the other end of the rope.

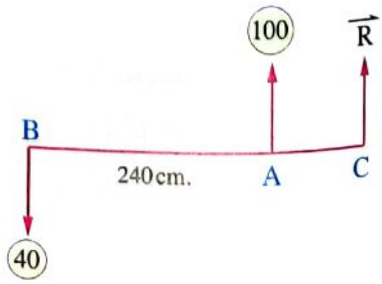
If the tension in the rope $\overline{DA} = 10\sqrt{29}$ newton. in magnitude , then the moment of the tension in the rope about the point C = ...

(a) $-120\hat{i} + 60\hat{k}$ (b) $120\hat{i} - 160\hat{j} + 60\hat{k}$

(c) $-120\hat{i} - 160\hat{j} + 60\hat{k}$ (d) $120\hat{i} + 60\hat{k}$

---

15 **In the opposite figure :**



$\overrightarrow{R}$ is the resultant of the two parallel forces 100 and 40

If AB = 240 cm. , then AC = ... cm.

(a) 100 (b) 120

(c) 160 (d) 200

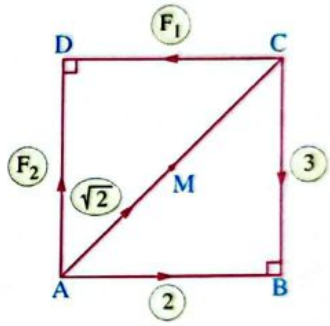
16 A thin lamina is uniform in the thickness and density in the shape of square ABCD of side length 48 cm. M is the point of intersection of its diagonals Δ CMD is cut to be fixed on Δ CMB such that $\overline{MD}$ coincides on $\overline{MB}$, then the distance between the centre of gravity of the lamina and the point B = …………… cm.

(a) $20\sqrt{2}$ (b) 20 (c) 40 (d) $4\sqrt{2}$

17 The centre of gravity of the following system. $M_1 = 1$ kg. at the position A (2 , 3) , $M_2 = 2$ kg. at the position B (– 2 , 1) , $M_3 = 3$ kg. at the position C (0 , 1) is ……………

(a) $\left(\frac{-1}{3}, \frac{4}{3}\right)$ (b) $\left(\frac{1}{3}, \frac{4}{3}\right)$ (c) $\left(\frac{-1}{3}, \frac{2}{3}\right)$ (d) $\left(\frac{1}{6}, \frac{4}{3}\right)$

18 **In the opposite figure :**



ABCD is a square. The shown forces are measured in dyne.

If the set of forces are in equilibrium

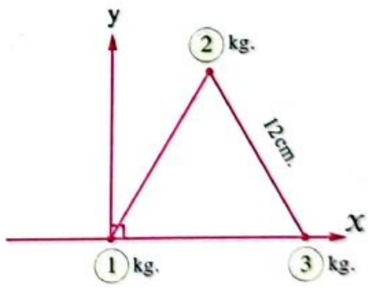
, then $F_1 - F_2$ = …………… dyne.

(a) 3 (b) 2

(c) 1 (d) – 1

19 The opposite figure represents an equilateral triangle of side length 12 cm.

Masses of magnitudes 1 , 2 , 3 kg. are placed at its vertices , then the centre of gravity of the system is ……………



(a) $(4, \sqrt{3})$ (b) $(\sqrt{3}, 4)$

(c) $(8, 2\sqrt{3})$ (d) $(2\sqrt{3}, 4)$

20 ABC is a uniform lamina in thickness and density in the shape of an equilateral triangle of side length $18\sqrt{3}$ cm. and of weight 100 gm.wt. acting at the point of intersection of its medians. The lamina is hanged at a horizontal thin nail perpendicular to the plane of the lamina in a small hole near by the vertex A such that the plane of the lamina is vertical. If a couple act on the lamina perpendicular to its plane to be in equilibrium when $\overline{AB}$ is horizontal , then the magnitude of the moment of this couple = …………… gm.wt.cm.

(a) $900\sqrt{3}$ (b) $1800\sqrt{3}$ (c) $450\sqrt{3}$ (d) 900

21 If $\overrightarrow{F_1} \,//\, \overrightarrow{F_2}$, $F_1 = 5$ N , R = 3 N , then $F_2 \in$ ....

(a) {2} (b) {8} (c) {2 , 8} (d) {3 , 5}

---

22 Two forces form a couple, the magnitude of each is 30 N. and the magnitude of the couple is 120 N. cm. If the magnitude of each force is increased by 5 N. , then the magnitude of the produced couple equals .... N.cm.

(a) 140 (b) 130 (c) 120 (d) 110

---

23 $\overline{AB}$ is a line segment of length 150 cm. Two bodies of masses 1 kg. , 3 kg. are placed at a distance 15 cm. from the end A , 50 cm. from the end B respectively , then a mass 2 kg. should placed at a distance = ... cm. from the end A such that the centre of gravity of the system lies at the midpoint of $\overline{AB}$

(a) 40 (b) 50 (c) 67.5 (d) 75

---

24 A uniform rod rests in a vertical plane on a smooth vertical wall with its upper end and on a rough horizontal plane with its lower end the coefficient of static friction between the horizontal plane and the rod equals $\frac{1}{4}$, then the tangent of the angle the rod makes to the horizontal when the rod is about to slide equals ....

(a) 0.5 (b) 1 (c) 1.2 (d) 2

---

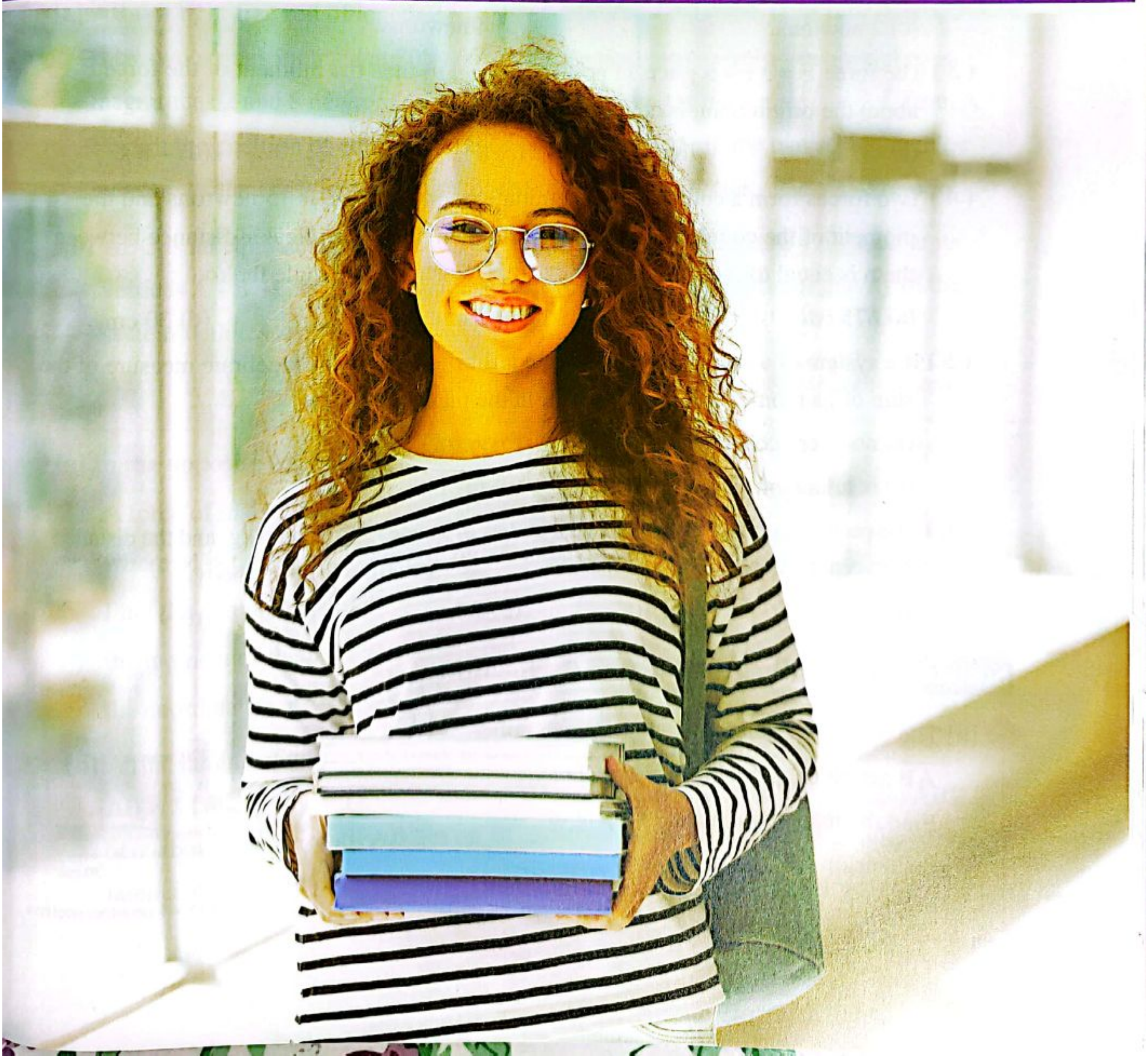
25 If A , B , C , D are points on the straight line L , force $\vec{F}$ acts such that $\vec{F}$ // the straight line L and $3\,M_A + 2\,M_B = 30$ N.cm. , then $3\,M_B - 2\,M_C + M_D =$ .... N.cm.

(a) 12 (b) 15 (c) 18 (d) 24

School Book Examinations

in

Statics



School Book Examinations

Model 1

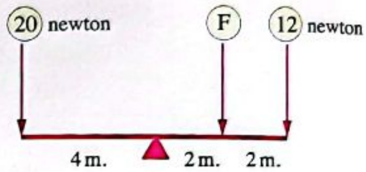
First — Answer the following questions

1 **Choose the correct answer :**

(1) If θ is the measure of the angle between the limiting friction force and the resultant reaction , then the coefficient of the static friction is equal to ....

(a) $\tan\theta$ (b) $\sin\theta$ (c) $\cos\theta$ (d) $\cot\theta$

(2) The opposite figure represents a rod in equilibrium , then F = ...



(a) 28 newtons. (b) 16 newtons.

(c) 2 newtons. (d) 4 newtons.

(3) The force $\vec{F} = 3\hat{i} - 5\hat{j}$ acts at point A $(-1 , 1)$, then the moment of the force $\vec{F}$ about the origin point is equal to ....

(a) $-2\hat{k}$ (b) $2\hat{k}$ (c) $8\hat{k}$ (d) $-8\hat{k}$

(4) Two forces form a couple , the magnitude of one of them is 15 newtons and the moment of the couple is 45 newton.cm. , then the perpendicular distance between them is equal to ....

(a) 675 cm. (b) 60 cm. (c) 3 cm. (d) 30 cm.

(5) If a system of a coplanar forces is in equilibrium , then the algebraic measure of the sum of its moments about any point in the plane is equal to ....

(a) non-zero constant. (b) zero.

(c) resultant of these force. (d) the unity.

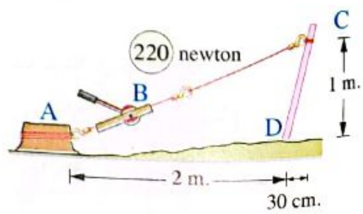
(6) The centre of gravity of two physical bodies of masses 3 kg. and 6 kg. and the distance between them is 15 cm. is at distance .... cm. from the 3 kg. body.

(a) 5 (b) 10 (c) 7.5 (d) 9

Second — Answer three questions of the following

2 **[a]** The opposite figure illustrates a winch puller $\overline{AB}$ acting on an inclined fence $\overline{CD}$

Find the magnitude of the moment of the tension force about point D



«175.44 newton.metre»

[b] A body of weight (W) is placed on a rough plane inclined at an angle of measure (θ) to the horizon. If the measure of the angle of friction is (λ) , find the magnitude and direction of the least force making the body about to move upwards. «W sin ($\theta + \lambda$)»

3 **[a]** Two like forces each of magnitude 10 , 15 newtons act at the two points A , B where AB = 75 cm. Find the resultant of the two forces. «25 newtons , 45 cm. far from A»

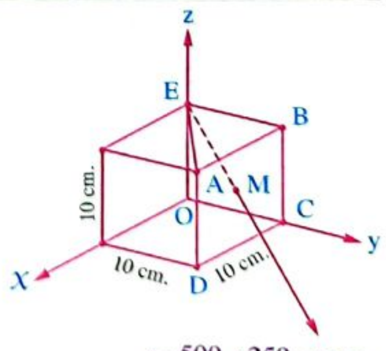
[b] ABC is an isosceles triangle in which AB = AC = 13 cm. and BC = 10 cm. forces of magnitudes 65 , F , 65 newtons act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CA}$ respectively. If the system is equivalent to a couple , what is the value of F and the magnitude of the moment of the couple ? «50 newtons , 600 newtons.cm.»

4 **[a]** AB is a light fine rod of length 2ℓ connected in a vertical plane at its two ends A , B by two strings inclined at 30° , 60° to the vertical respectively , two weights of magnitudes 2 and 8 newtons. are suspended on the rod at distant $\frac{1}{5}\ell$, $\frac{6}{5}\ell$. from A. Find in the position of equilibrium the tension magnitude in the two strings and the measure of the angle of inclination of the rod to the horizontal. «$5\sqrt{3}$, 5 newtons , 30°»

[b] ABC is an equilateral triangle of side length 10 cm. the weights 3 , 6 , 9 act at its vertices A , B , C respectively. Identify the position of the centre of gravity of the system with respect to the point C

«$\left(4\frac{1}{6}, \frac{5\sqrt{3}}{6}\right)$ considering $\overrightarrow{CB}$ and its perpendicular from C are two positive coordinate axes»

5 **[a] In the opposite figure :**



A force of magnitude $25\sqrt{6}$ newton acts at $\overrightarrow{EM}$ where M is the geometric centre of the square ABCD Find the components of the moment of the force about the coordinate axes. «-500 , 250 , zero»

[b] A fine lamina of uniform density in the form of a rectangle ABCD in which : AB = 5 cm. , BC = 12 cm. , E $\in \overline{AD}$ such that AE = 5 cm. The triangle ABE is bent about side $\overline{BE}$ until $\overline{AB}$ lies on $\overline{BC}$ totally. Identify the centre of gravity of the lamina after bending it with respect to $\overrightarrow{CB}$, $\overrightarrow{CD}$ «$\left(\frac{155}{72} \text{ cm.}, \frac{407}{72} \text{ cm.}\right)$»

School Book Examinations

Model 2

First Answer the following questions

1 Choose the correct answer :

(1) Two couples act on a body , the magnitude of one of the two forces of the first couple is 20 kg.wt. the moment arm is $\frac{1}{2}$ m. and the direction of its rotation is in anti clockwise direction while the magnitude of one of the two forces of the second couple is 30 kg.wt. moment arm is 1 m. and the direction of its rotation is in the clockwise direction then the resultant couple is equal to ....

(a) 20 kg.wt.m. and the direction of its rotation is in the clockwise direction.

(b) 20 kg.wt.m. and the direction of its rotation is in the anti-clockwise direction.

(c) 40 kg.wt.m. and the direction of its rotation is in the clockwise direction.

(d) 40 kg.wt.m. and the direction of its rotation is in the anti-clockwise direction.

(2) The angle of friction is ....

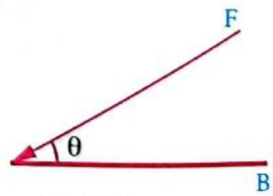
(a) the angle included between the normal reaction and the resultant reaction in the case of limiting friction.

(b) the ratio between the force of limiting friction and the normal reaction.

(c) the ratio between the coefficients of static and kinetic friction.

(d) the angle included between the force of the limiting friction and the resultant reaction.

(3) The opposite figure illustrates a force of magnitude F acts on an end of a rod. The measure of angle θ which generates the maximum moment about points B is ....



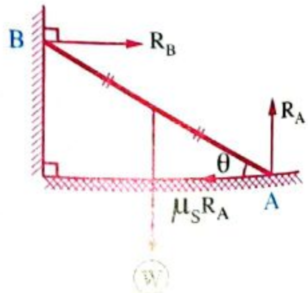
(a) 0° (b) 90° (c) 45° (d) 30°

(4) Two unlike forces , the magnitude of one of them is 7 newtons and the magnitude of their resultant is 10 newtons , then the magnitude of the other force is ....

(a) 3 newtons. (b) 17 newtons. (c) 27 newtons. (d) 6 newtons.

(5) **In the opposite figure :**

If λ is the angle of friction between the ground and the rod , then $\tan\theta \cdot \tan\lambda =$ ....



(a) 2 (b) $\frac{1}{2}$

(c) 1 (d) 3

(6) A mass of 5 kg. acts at the point (2 , – 1) and a mass of 7 kg. acts at the point (1 , 2) , then the centre of gravity of the two masses acts at the point ....

(a) (17 , 9) (b) $\left(\frac{17}{12} , \frac{3}{4}\right)$ (c) (19 , 13) (d) $\left(\frac{19}{12} , \frac{1}{4}\right)$

Second Answer three questions of the following

2 [a] If the force $\vec{F} = 5\hat{i} - \hat{j} + 3\hat{k}$ acts at the point A (– 1 , 2 , 1)

Find : (1) The moment of the force $\vec{F}$ about the origin point.

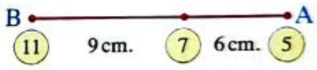
(2) The length of the perpendicular drawn from the origin point on the line of action of $\vec{F}$

«$7\hat{i} + 8\hat{j} - 9\hat{k}$, 2.35 length unit»

[b] Prove that if a body is placed on a rough inclined plane , and the body is about to slide , then the measure of the angle of friction is equal to the measure of the angle of inclination of the plane on the horizontal.

---

3 [a] Three bodies of weights 5 , 7 , 11 kg.wt. are placed on a light rod as shown in the figure. Identify the suspension point on the rod such that the rod remains horizontal.



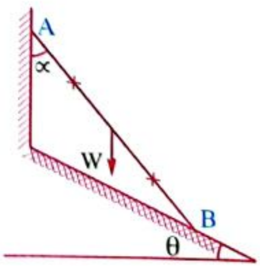
«9 cm. far from the point A»

[b] ABCD is a rectangle in which AB = 6 cm. , BC = 8 cm. , E $\in \overline{BC}$, G $\in \overline{AD}$ such that : BE = DG = 6 cm. The forces of magnitudes 5 , 5 , 7 , 7 , F , F kg.wt. act at the directions of $\overrightarrow{AB}$, $\overrightarrow{CD}$, $\overrightarrow{BC}$, $\overrightarrow{DA}$, $\overrightarrow{EA}$, $\overrightarrow{GC}$, respectively if the system is equivalent to a couple whose moment magnitude is 10 kg.wt.cm. in the direction of CBAD **Find :** F

«$46\sqrt{2}$ kg.wt.»

---

4 [a] **In the opposite figure :**



The top of a uniform ladder weight (W) is leaning against a smooth vertical wall and its base is leaning against a rough ground inclined to the horizontal at an angle of measure (θ) upwards. If the ladder is about to slide while it is in a vertical plane perpendicular to the intersection line of the wall and ground , prove that the ladder is inclined at an angle of measure ∝ to the vertical where tan ∝ = 2 tan (λ – θ) where λ is the angle of friction.

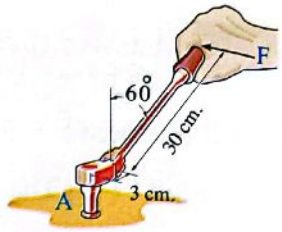
[b] A uniform rod $\overline{AC}$ of the length 15 ℓ is bent from point B where $\overline{AB} = 5\ \ell$ such that m ($\angle$ ABC) = 90° and a rod is suspended freely from end A
Prove that $\overline{BC}$ is inclined at an angle of θ where $\tan\theta = \frac{4}{5}$ to the horizontal.

---

5 **[a] In the opposite figure :**

If the moment of the force F perpendicular to the rotation arm about point A is equal to 620 newtons.cm.

Find : F «19 newtons»



[b] ABC is an equilateral triangle of side length 20 cm. , M is the intersection point of its medians , D is the midpoint of $\overline{BC}$, masses of magnitudes 15 , 30 , 75 , 45 , 45 are fixed at the points A , B , D , C , M respectively. Identify the centre of gravity of this system. Where does the centre of gravity of the remaining system lie if the mass existed at B is lifted?

«$\left(\frac{65}{7}, \frac{10\sqrt{3}}{7}\right)$, $\left(\frac{15}{2}, \frac{5\sqrt{3}}{3}\right)$ considering $\overrightarrow{CB}$ and its perpendicular from C are two positive coordinate axes»

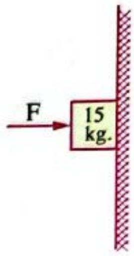
School Book Examinations

Model 3

First — Answer the following questions

1 Complete :

(1) In the opposite figure :

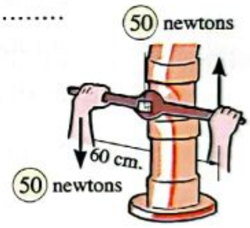


The magnitude of the least horizontal force $\vec{F}$ needed to equilibrate a body of mass 15 kg. on a rough vertical plane the coefficient of the static friction between it and the body is equal to $\frac{1}{5}$ is equal to .... kg.wt.

(2) A force of magnitude 70 newtons acts at $\overrightarrow{AB}$ where ABCD is a square of side length 10 cm. , then the magnitude of the moment of the force about the centre of the square is equal to ....

(3) If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$, $\overrightarrow{F_1} = \hat{i} - 2\hat{j}$, $\|\overrightarrow{F_2}\| = 4\sqrt{5}$ unit , then $\overrightarrow{F_2} =$ ....

(4) In the opposite figure :



The moment of the couple resulted from the two forces 50 , 50 is equal to ....

(5) When a rod is placed in a smooth spherical container , it is in equilibrium when the line of action of weight passes ....

(6) The centre of gravity of the triangular uniform lamina lies at ....

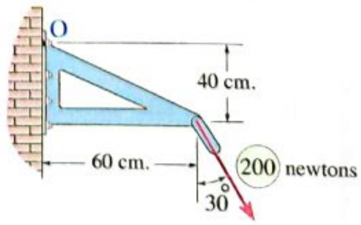
Second — Answer three questions of the following

2 **[a]** A body of weight $66\frac{2}{3}$ newtons is placed on a rough horizontal plane. The coefficient of friction between them is equal to $\frac{3}{4}$ A force of magnitude 40 newtons acts on the body and inclined at an acute angle of measure θ to the horizontal plane. What is the value of θ if the body is about to move ?

«36° 52̀»

[b] In the opposite figure :

Find the moment of the force 200 newtons about O



«– 6392.3 newtons. cm.»

3 [a] $\overline{AB}$ is a non uniform rod of length 1 m. it rests in a horizontal position on two supports at C , D where AC = 20 cm. , BD = 10 cm. If the heaviest weight can be suspended at point A or point B without disturbing the rod is 5 , 4 kg.wt. respectively. Find the weight of the rod and its point of action. «2 kg.wt. , 70 cm. far from the point A»

[b] ABCDEF is a uniform hexagon of side length 10 cm. The forces of magnitudes 2 , 5 , 4 , 6 , 1 , 3 newtons acts at $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$, $\overrightarrow{ED}$, $\overrightarrow{EF}$, $\overrightarrow{AF}$ respectively.

Find the magnitude and direction of the force which should act at the centre of the hexagon in order to reduce the system to a couple , then identify its moment.

«$\sqrt{3}$ newton in $\overrightarrow{CA}$ direction , $-35\sqrt{3}$ newton.cm.»

---

4 [a] $\overline{AB}$ is a uniform rod of weight (W) is leaning by one of its ends A on smooth horizontal ground and its end B on a smooth plane inclined to the horizontal at an angle twice the measure of the angle of inclination of the rod to the horizontal in an equilibrium. The rod in being kept by a string one of its ends is connected to the end of the rod leaning on the horizontal ground and the other end of the string is in a point on the intersection line of the inclined plane with the horizontal plane. Find the magnitude of tension in the string and the two reactions at the two ends of the rod when the rod inclines at 30° to the horizontal. «$\frac{\sqrt{3}}{4}$ W , $\frac{3}{4}$ W , $\frac{W}{2}$»

[b] ABCD is a fine uniform lamina in the form of a square of side length ℓ If E , F , N are the midpoints of $\overline{AB}$, $\overline{AD}$, $\overline{BC}$ respectively. The triangle AEF is bent about $\overline{EF}$ such that A is coincident on the centre of the square M and the triangle BEN on $\overline{EN}$ such that the vertex B is coincident on the centre of the square M

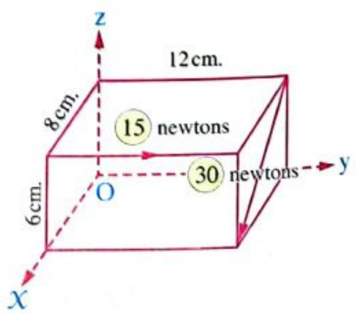
Identify the centre of gravity of the lamina in its new position.

«$(-\frac{1}{24}\ell , 0)$ considering $\overrightarrow{ME}$, $\overrightarrow{MF}$ are two positive coordinate axes»

---

5 [a] **In the opposite figure :**

Find the sum of moments of the forces about O



«$-306\hat{i} + 144\hat{j} - 168\hat{k}$»

[b] **Find the centre of gravity for the following distribution :**

W_1 = 20 newtons acts at (2 , 1) , W_2 = 15 newtons acts at (– 3 , 1) , W_3 = 25 newtons act at (1 , – 1) «$(\frac{1}{3} , \frac{1}{6})$»

School Book Examinations

Model 4

First Answer the following questions

1 Choose the correct answer :

(1) The coefficient of friction is based upon ....

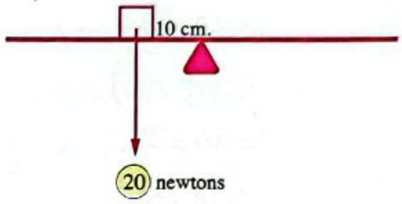
(a) the area of the contact surface between two bodies.

(b) shape of the two bodies.

(c) nature of the two bodies.

(d) all mentioned.

(2) The opposite figure represents a uniform rod leaning on a support at its midpoint. A body is placed on the rod as shown in the figure. Which of the following forces makes the rod be in equilibrium ?



(a) A force of magnitude 10 newtons upwards act on a distance 20 cm. on the right of the rod midpoint.

(b) A force of magnitude 10 newtons downwards acts on a distance 20 cm. on the right of the rod midpoint.

(c) A force of magnitude 30 newtons upwards acts on a distance 5 cm. on the left of the rod midpoints.

(d) A force of magnitude 30 newtons downwards act on a distance 5 cm. on the left of the rod midpoint.

(3) The force $\overrightarrow{F} = F_x \hat{i} + F_y \hat{j} + F_z \hat{k}$ acts at point A whose position vector with respect to the origin point is $A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$, then the component of moment of $\overrightarrow{F}$ about x-axis is ....

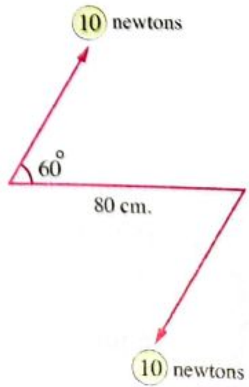
(a) $F_x \times A_z - F_z \times A_x$

(b) $-F_y \times A_z + F_z \times A_y$

(c) $F_x \times A_y + F_y \times A_x$

(d) $F_y \times A_y + F_z \times A_z$

(4) Magnitude of the moment of the opposite couple is equal to ....



(a) 800 newtons cm.

(b) 400 newtons cm.

(c) $400\sqrt{3}$ newtons cm.

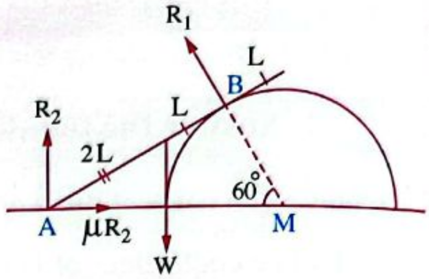
(d) $-400\sqrt{3}$ newtons cm.

(5) In the opposite figure :

If the rod is about to slide

, then $R_1 = \dots\dots\dots\dots$

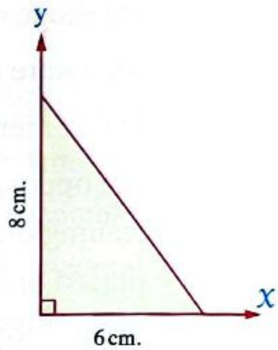
, $R_2 = \dots\dots\dots\dots$



(a) W (b) $\frac{1}{2}$ W

(c) $\frac{\sqrt{3}}{2}$ W (d) $\frac{\sqrt{3}}{3}$ W

(6) The centre of gravity of the regular density shaded lamina in the opposite figure is $\dots\dots\dots\dots$



(a) $\left(2 , \frac{8}{3}\right)$

(b) $\left(\frac{8}{3} , 2\right)$

(c) (6 , 8)

(d) (8 , 6)

Second Answer three questions of the following

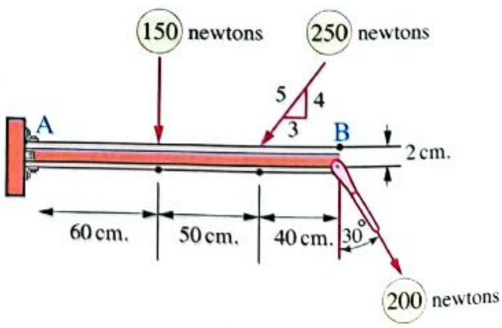
2 **[a]** A body of weight 16 kg.wt. is placed on a plane inclined at 30° to the horizontal and the coefficient of friction between it and the body is equal to $\frac{1}{\sqrt{3}}$

A force in the line of the greatest slope of the plane acts on the body upwards and with magnitude 10 kg.wt. If the body is in equilibrium , identify the friction force and show whether the body is about to move or not. «2 kg.wt. , is not about to move»

[b] In the opposite figure :

Three coplanar forces act on the rod $\overline{AB}$

Find the algebraic measures of the sum of the moments of the forces about each of the two points A , B



«– 56780.8 , 21700 kg.wt.cm.»

3 **[a]** A uniform rod of length 4 metres rests at its midpoint. Two weights of 4 , 3 kg.wt. are suspended in one of its two halves distant 1 , 1.5 m. from its midpoint respectively and two other weights of 5 kg.wt. , W kg.wt. are suspended in the other half distant $\frac{1}{2}$, 2 m. from its midpoint respectively. What is the value of W if the rod is in equilibrium ?

kg.wt.»

[b] ABC is a uniform lamina in the form of an equilateral triangle of side length $30\sqrt{3}$ cm. and weight 50 gm.wt. the lamina is suspended by a horizontal pin from a hole close to vertex A to be vertically in equilibrium. A couple perpendicular to the surface of the lamina acts on the lamina to be in equilibrium in a position $\overline{AB}$ is horizontal.

Find the moment of the couple acting and the reaction of the pin.

«$750\sqrt{3}$ gm.wt.cm. , 50 gm.wt.»

---

4 **[a]** $\overline{AB}$ is a uniform rod. Its end A is connected to a hinge fixed in a vertical wall and end B is connected by an end of a string and the other end of the string is connected by a point in the horizontal plane passing through the hinge such that each of the rod and the string inclined at an angle of measure θ to horizontal. If (W) is the weight of the rod , show that the reaction of the hinge at A is equal to $\frac{W}{4}\sqrt{8 + \csc^2 \theta}$

[b] ABCD is a square of side length 20 cm. Four masses equal in magnitudes are placed at its vertices.

(1) Identify the centre of gravity of the system.

(2) Where does the centre of gravity of the remaining system lie if the mass placed at a one of the vertices is ceased ?

«The geometrical centre of the square , the centroid of the triangle joining the remaining masses»

---

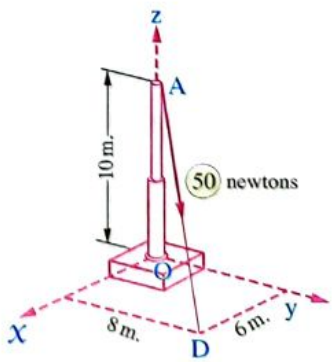
5 **[a]** ABC is a regular lamina in the form of an equilateral triangle whose weight is 3 kg. and M is its centre of gravity. Masses of magnitudes 2 , 2 , 11 kg. are placed at the vertices A , B , C respectively.

Prove that the centre of gravity of the system lies at the midpoint of $\overline{MC}$

[b] In the opposite figure :

A force of magnitude 50 newtons acts at point A

Find the moment of the force about point O



«$-200\sqrt{2}\,\hat{i} + 150\sqrt{2}\,\hat{j}$»

School Book Examinations

Model 5

First — Answer the following questions

1 Complete :

(1) The coefficient of the static friction is the ratio between ....

(2) If the force $\overrightarrow{F} = 2\hat{i} - \hat{j} + 5\hat{k}$ acts at point A whose position vector is $\hat{i} - 3\hat{k}$, then the moment of $\overrightarrow{F}$ about point B whose position vector is $\hat{j} + 3\hat{k}$ is equal to ....

(3) Two like forces , the magnitude of one of them is twice the magnitude of the second and the magnitude of their resultant is 31 newtons , then the magnitude of the smaller force is equal to ....

(4) If the two forces $\overrightarrow{F_1} = A\hat{i} + 5\hat{j}$, $\overrightarrow{F_2} = 3\hat{i} - B\hat{j}$ form a couple , then $A + B =$ ....

(5) The necessary and sufficient condition for the equilibrium of a system of coplanar forces ....

(6) The centre of gravity of the rigid body suspended freely on the vertical straight line passing through ....

Second — Answer three questions of the following

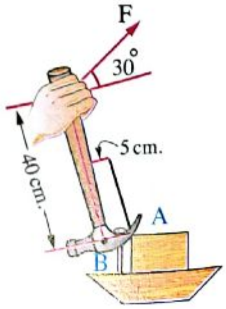
2 **[a]** A body of weight 50 newtons is placed on a rough inclined plane inclined at an angle of measure θ to the horizontal. The least and greatest forces parallel to the line of the greatest slope and makes the body in equilibrium on the plane are 10 , 40 newtons respectively. Find the coefficient of static friction and the measure of the angle of inclination of the plane to the horizontal.

«$\frac{\sqrt{3}}{5}$, 30°»

[b] The opposite figure illustrates the force F needed to remove a nail at B

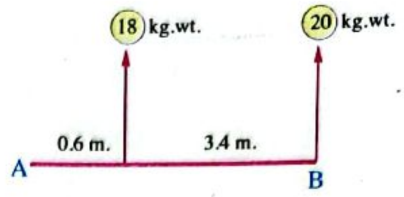
If the magnitude of the moment of the force about point A needed to remove the nail is equal to 200 newton cm.

Find the magnitude of the force F



«3.38 newton»

3 [a] If the resultant of three forces act on the rod $\overline{AB}$ of negligible weight in the figure is 13.6 kg.wt. and acting upwards distant 3 metres on the right of A Find the magnitude direction and point of action of the third force.



«24.4 kg.wt. and 2.05 m. downward from the point A»

[b] ABCD is a rectangle which AB = 12 cm. , BC = 9 cm. , $M \in \overline{BC}$ such that BM = 4 cm. forces of magnitudes F_1 , $8\sqrt{10}$, 26 , F_2 , 18 newton in the directions $\overrightarrow{BA}$, $\overrightarrow{AM}$, $\overrightarrow{MD}$, $\overrightarrow{DC}$, $\overrightarrow{DA}$ respectively. If the system of forces is in equilibrium , find the value for each of F_1 , F_2

«24 , 24 newton»

---

4 [a] $\overline{AB}$ is a uniform ladder of length 5 m. and weight 20 kg.wt. rests with its end A on a smooth vertical wall and on rough horizontal ground with its end B and the coefficient of static fricition between them is $\frac{1}{4}$ and the end B is at a distant 3 m. from the wall. Prove that the ladder is not in equilibrium in this case , then find the smallest weight of the body which the coefficient of static friction between it and the ground is $\frac{1}{5}$ such that if it is placed at the end B of the ladder , it stops the ladder from sliding.

«$12\frac{1}{2}$ kg.wt.»

[b] A uniform wire of length 100 cm. is bent in the form of five sides of a uniform hexagon ABCDEF and starts from point A , Identify the distance between its centre of gravity and that of the hexagon. If the wire is freely suspended from end A , identify the measure of the angle of inclination of $\overline{AB}$ to the vertical in the equilibrium state.

« $2\sqrt{3}$, $55° \; 42'$»

---

5 [a] $\overline{AB}$ is a uniform rod of length 2 m. and weight 5 newtons C , D are two trisection points from direction A , weights of magnitudes 1 , 2 , 3 , 4 newtons are connected at point A , C , D , B respectively. Identify the centre of gravity of the system.

«$\frac{11}{9}$ m. from the point A»

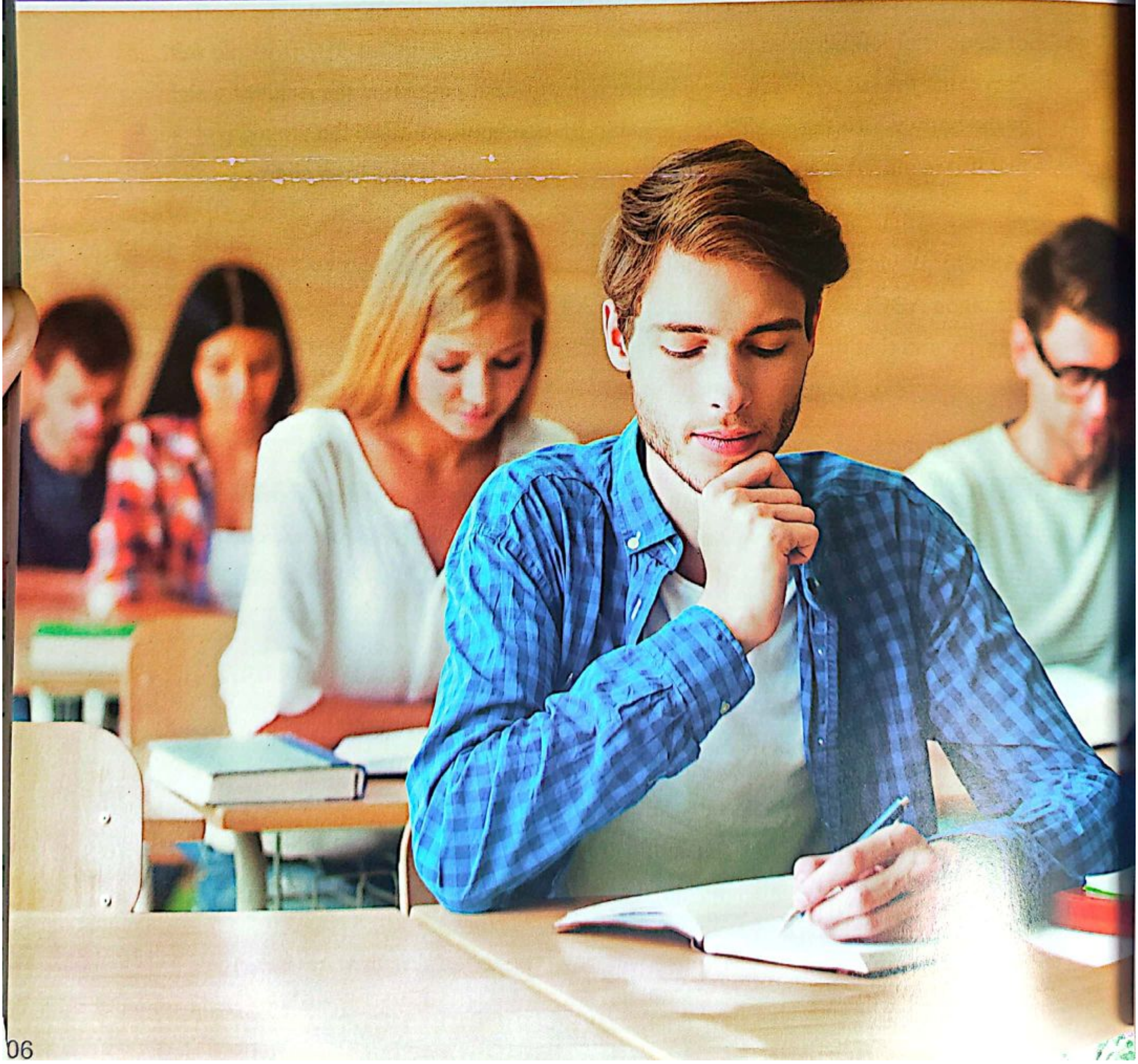
[b] Two forces $\overrightarrow{F_1} = 2\hat{i} - \hat{j}$, $\overrightarrow{F_2} = \hat{j} - 2\hat{i}$ act at two points A (1 , 1) , B (0 , – 4) respectively. Find the moments of the system about any point on the plane.

«$-11\hat{k}$»

Egypt Exams
(2017 : 2021 first and second sessions)

in

Statics



Egypt exams

1^{st} session 2017

Answer the following questions :

1. If $\overrightarrow{F_1} = 4\hat{i} + b\hat{j}$, $\overrightarrow{F_2} = a\hat{i} - 6\hat{j}$ are two forces form a couple , then a + b = ...

(a) – 10 (b) 2 (c) – 2 (d) 10

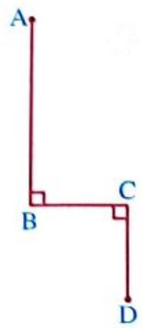
2. ABCD is a trapezium in which $\overline{AD} \parallel \overline{BC}$, m (∠ B) = 90° , AB = 12 cm. , BC = 18 cm. , AD = 9 cm. , force of magnitudes 20 , 60 , 50 , 120 and $30\sqrt{13}$ gm.wt. act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DA}$ and $\overrightarrow{AC}$ respectively. Prove that the system is equivalent to a couple and find its moment.

3. ABCD is a thin rectangular lamina in which AB = 18 cm. , BC = 24 cm. , its weight equals 20 newton acting at the point of intersection of the two diagonals. The lamina is suspended by a thin pin passing through a small hole near the vertex D so that its plane is vertical. If a couple the magnitude of its moment is 150 newton. cm. and its direction is perpendicular to the plane of the lamina acted on it. find the inclination angle of $\overline{DB}$ to the vertical in the position of equilibrium.

4. The centre of gravity of the system consists of two masses 4 , 8 kg. and the distance between them is 6 m. lies at a distance .... m. from the first mass.

(a) 3 (b) 4 (c) 2 (d) 5

5. **In the opposite figure :**



If ABCD is a uniform wire of length 32 cm. where :

AB = 2 BC = 2 CD = 16 cm. , then the distance from the centre of gravity of the wire to each of $\overleftrightarrow{BC}$ and $\overleftrightarrow{BA}$ respectively is ....

(a) (3 , 3) (b) (4 , 4)

(c) (3 , 5) (d) (4 , 8)

6. A fine lamina of uniform thickness and density , in the form of a trapezium ABCD in which m (∠ A) = m (∠ D) = 90° , CD = 40 cm. , AD = 60 cm. , AB = 120 cm.
Find the distance from the centre of gravity of the lamina and each of $\overline{AD}$ and $\overline{AB}$

7. A body of weight 35 newton is placed on a rough horizontal plane , two horizontal forces act on the body of magnitudes 6 newton and 10 newton and including between them an angle of measure 60° If the body is about to move , then the coefficient of static friction equals ....

(a) $\frac{2}{5}$ (b) $\frac{1}{14}$ (c) $\frac{3}{7}$ (d) $\frac{1}{10}$

8. If a body of weight 4 newton is placed on a rough horizontal plane , the coefficient of static friction between the plane and the body = $\frac{1}{4}$, and a horizontal force acts on the body trying to move it, then the static friction force $\in$ ....

(a) $[\frac{1}{4}, 4]$ (b) $[1, \infty[$ (c) $]0, 1]$ (d) $[0, \frac{1}{4}]$

9. ***Answer one of the following items :***

[a] If the force $\vec{F} = 2\hat{i} + 3\hat{j} - \hat{k}$ acts at point A (1 , – 1 , 4) find the moment vector of the force $\vec{F}$ about point B (2 , – 3 , 1) , then calculate the length of the perpendicular drawn from the point B on the line of action of the force.

[b] The forces $\vec{F_1} = 2\hat{i} - 3\hat{j}$, $\vec{F_2} = 5\hat{i} - 2\hat{j}$, $\vec{F_3} = -3\hat{i} + 2\hat{j}$ act at the point A (– 3 , 5) , find the moments vector of the resultant of these forces about the point B (1 , 7) and the distance between the point B and the line of action of the resultant.

10. If $\vec{F} = (2, -3, 4)$ acts at the point (1 , 1 , 1) , then the component of the moment of $\vec{F}$ about y-axis equals ....

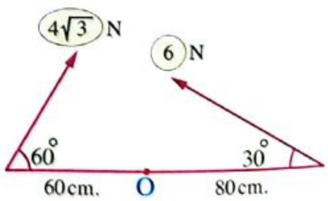
(a) 7 (b) – 2 (c) – 5 (d) 2

11. **In the opposite figure :**

The sum of the moments of the forces about the point O equals .... N.cm.

(a) – 120 (b) 120

(c) 240 (d) – 360

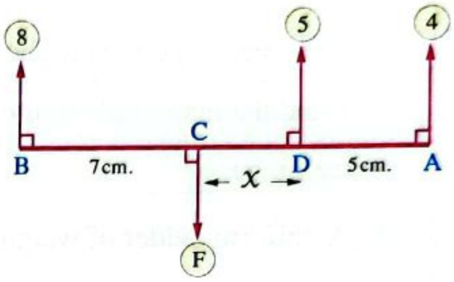


12. A body of weight 400 gm.wt. is placed on rough plane inclined to the horizontal by an angle of measure 30° , the coefficient of static friction between it and the body is $\frac{\sqrt{3}}{4}$ A force of magnitude 50 gm.wt. acts on it in the direction of the line of the greatest slope of the plane upwards. If the body is in equilibrium , then determine the friction force and show whether the body is about to move or not.

13 $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces act in opposite directions. If $F_1 = 7$ newton , $F_2 = 9$ newton , and the distance between the resultant and the second force equals 35 cm. , then the distance between the two forces equals .... cm.

(a) 10 (b) 16 (c) 35 (d) 70

14 **In the opposite figure :**



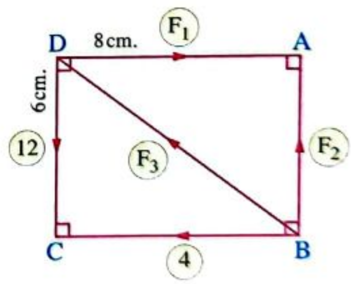
If $\overline{AB}$ is a rod is in equilibrium horizontally , then the distance $x =$ .... cm.

(a) 56 (b) 36

(c) 27 (d) 4

15 Find the magnitude and the point of action of the resultant of two parallel forces of magnitude 7 newton , 12 newton act at A and B in two opposite directions such that AB = 20 cm.

16 **In the opposite figure :**



If the magnitude of the forces in newton and the system is in equilibrium , then $F_2 =$ .... newton.

(a) 16 (b) 5

(c) 3 (d) 8

17 $\overline{AB}$ is a uniform wooden board of mass 10 kg. and length 4 metres rests horizontally on two supports one of them at A and the other at a point distant 1 metre from B

Show at which distance a 50 kg.wt. child can stand on the board in order to the reactions on the two supports get equal.

18 ***Answer one of the following items :***

[a] $\overline{AB}$ is a rod of negligible weight and of length 210 cm. , is hanged at A to a hinge fixed at a vertical wall. It carried at B a weight of magnitude 120 newton.

The rod is kept in a horizontal position by means of a light string attached at the end B of the rod , its other end is fixed at a point on the wall lying vertically above A.

If the string inclined to the horizontal at an angle of measure 30°

, find the magnitude of the tension in the string and the magnitude of the reaction of the hinge.

[b] A uniform ladder of weight 20 kg.wt. rests at one of its ends on a rough horizontal ground and with its other end against a smooth vertical wall such that the ladder equilibrium in a vertical plane , inclining to the horizontal at an angle of measure 60°

If the coefficient of static friction between the ladder and the ground is $\frac{1}{2\sqrt{3}}$, prove that the maximum distance which a girl of weight 60 kg.wt. can ascend the ladder equals half the length of the ladder.

Answer the following questions :

1. Two parallel forces of magnitudes 40 , 100 newton act in two opposite directions. If the distance between their lines of action equals 240 cm. , then find their resultant and its point of action.

2. If $\overrightarrow{F_1} = 3\,\hat{i} - b\,\hat{j}$, $\overrightarrow{F_2} = a\,\hat{i} - 5\,\hat{j}$ are two forces form a couple , then (a , b) = ...

   (a) (3 , – 4) (b) (3 , 5) (c) (– 3 , 5) (d) (–3 , – 5)

3. ***Answer one of the following items :***

   [a] A uniform rod $\overline{AB}$ of length 120 cm. and of weight 4 newton , is hinged at A to a hinge fixed at a vertical wall. A weight of magnitude 3 newton is attaced to the rod at a point 40 cm. apart from B the rod is kept in a static equilibrium in a horizontal postion by means of a string attached at the end B of the rod , its other end is fixed at a point C on the wall lying vertically above A such that AC = 160 cm. Find the magnitude of the tension in the string and the magnitude and the direction of the reaction of the hinge.

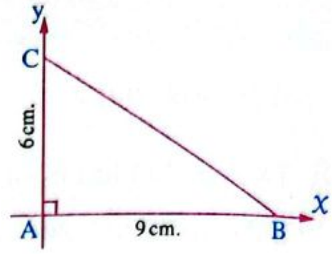
   [b] A uniform rod rests with its upper end on a vertical wall ; the coefficient of static friction between the rod and the wall is equal to $\frac{1}{2}$. If the rod rests with its lower end on a horizontal plane ; the coefficient of static friction between the rod and the plane is equal to $\frac{3}{4}$. Find the tangent of the angle which the rod makes with the horizontal when it is about to slip.

4. ABCD is a square whose side length is 100 cm. , two forces of magnitudes 60 , 60 newton act in the direction of $\overrightarrow{BA}$, $\overrightarrow{DC}$. Find two forces equal in the magnitude , acting at A and C , parallel to $\overleftrightarrow{BD}$ and forming a couple equivalent to the couple formed by the first two forces.

5. ABCD is a rectangle in which AB = 9 cm. , BC = 24 cm. , E and F are midpoints of $\overline{BC}$ and $\overline{AD}$ respectively. The forces of magnitudes 18 , 48 , 30 and 24 gm. wt. act in the direction of $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CF}$ and $\overrightarrow{FA}$ respectively prove that the system is equivalent to a couple and find the norm of its moment , then find two forces acting along $\overrightarrow{EA}$, $\overrightarrow{FC}$ so that the system is in equilibrium.

6 **In the opposite figure :**

The centre of gravity of three equal masses each of magnitude = 2 kg. are fixed at the vertices of a right-angled triangle in which the length of the sides of its right angle are 6 cm. , 9 cm. is ....



(a) (2 , 3) (b) (4.5 , 3)

(c) (3 , 2) (d) (6 , 4)

---

7 The centre of gravity of the system consists of two masses 6 and 9 kg. and the distance between them is 10 m. lies at a distance .... meters from the first mass.

(a) 3 (b) 4 (c) 5 (d) 6

---

8 Four equal masses , each of magnitude 100 gm. are placed at the vertices of a square ABCD , determine the distance between the centre of gravity of the system and both $\overrightarrow{AB}$ and $\overline{AD}$

---

9 A body of weight 21 newton is placed on a rough horizontal plane , two horizontal forces act on the body of magnitudes 3 newton and 5 newton and include an angle of measure 60°. If the body is about to move , then the coefficient of static friction equals ....

(a) $\frac{3}{7}$ (b) $\frac{1}{7}$ (c) $\frac{1}{3}$ (d) $\frac{3}{5}$

---

10 If the limiting static friction force = 60 newton , the resultant reaction force equals 100 newton , then the normal reaction force = ... newton.

(a) 60 (b) 80 (c) 100 (d) 200

---

11 A body of weight (w) is placed on rough plane inclined to the horizontal at an angle of measure (θ). If the least force acting parallel to the line of the greatest slope of the plane to make the body about to move upwards the plane equals (2 w sin θ)

Prove that :

[a] The measure of the angle of friction = θ

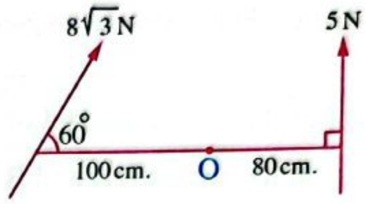
[b] The magnitude of the resultant reaction force = w

12 If $\vec{F} = (2 , -3 , 4)$ acts at the point $(1 , 1 , 1)$, then the component of the moment of $\vec{F}$ about the x-axis equals ....

(a) 7 (b) -2 (c) -5 (d) 2

---

13 **In the opposite figure :**



The sum of the moments of the forces about the point O equals .... N. cm.

(a) 800 (b) -800

(c) 400 (d) -1200

---

14 ***Answer one of the following items :***

[a] If the force $\vec{F} = 2\,\vec{i} - \vec{j} + 3\,\vec{k}$ acts at the point A $(-3 , 1 , 2)$, find the moment vector of the force $\vec{F}$ about the point B $(2 , 2 , -1)$, then calculate the length of the perpendicular drawn from the point B on the line of action of the force.

[b] The forces $\vec{F_1} = \ell\,\vec{i} + m\,\vec{j}$, $\vec{F_2} = \vec{i} - 3\,\vec{j}$, $\vec{F_3} = -2\,\vec{i} + \vec{j}$ act at the points A $(1 , 2)$, B $(0 , 4)$, C $(2 , 4)$ respectively. If the sum of the moments of the forces about the origin point $= -9\,\vec{k}$ and the sum of the moment of the forces about the point D $(-2 , 3)$ equals $-4\,\vec{k}$ Find the value of each of ℓ and m

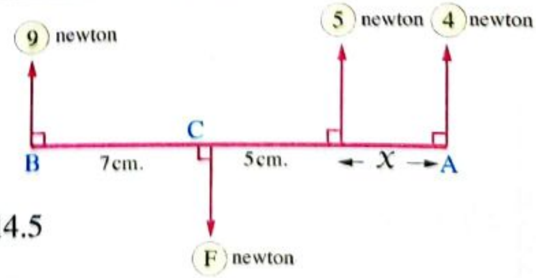
---

15 $\vec{F_1}$ and $\vec{F_2}$ are two parallel forces act in opposite directions. If $F_1 = 6$ newton , $F_2 = 8$ newton. If the distance between the second force and the resultant equals 15 cm. , then the distance between the two forces equals .... cm.

(a) 30 (b) 15 (c) 14 (d) 5

---

16 **In the opposite figure :**



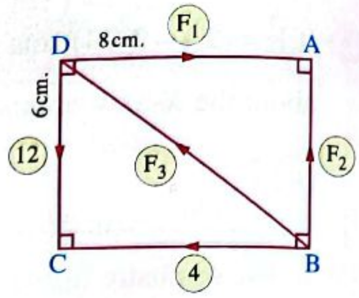
If $\overline{AB}$ is a rod is in equilibrium horizontally , then the distances $x =$ .... cm.

(a) 9.5 (b) 14.5

(c) 4.5 (d) 18

17 **In the opposite figure :**

If the magnitude of the forces is in newton , the system is in equilibrium , then F_1 = ... newton.



ⓐ 16 ⓑ 5

ⓒ 3 ⓓ 8

18 $\overline{AB}$ is a uniform rod of length 90 cm. and of weight 60 newton suspended horizontally at its two ends A and B by two vertical strings. Where should a weight of magnitude 150 newton be suspended in order that the magnitude of the tension at A is twice the magnitude of the tension at B ?

Egypt exams

1st session 2018

Answer the following questions :

1. A body of weight 36 newton is placed on a rough horizontal plane. If the coefficient of the static friction between the body and the plane equals $\frac{1}{3}$ and a horizontal force acts on the body trying to move it , then the magnitude of the friction force $\in$ ....

   (a) $]\frac{1}{3}, 12]$ (b) $]\frac{1}{3}, 36]$

   (c) $]0, 12]$ (d) $]0, 36]$

2. If a set of forces are in equilibrium , then ....

   (a) only the sum of the moments of the forces about any point vanishes.

   (b) only the resultant of the forces vanish.

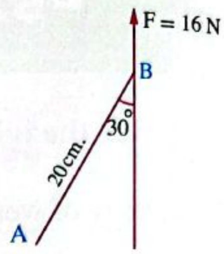
   (c) the sum of the moments of the forces about any point vanishes and the resultant of the forces vanish.

   (d) the resultant of the forces equals the sum of the magnitudes of the forces and the sum of the moments of the forces about any point are not vanishes.

3. A , B , C and D are four different points lying on a straight line where : AB = BC = CD = 30 cm. Two forces of magnitudes 8 , 9 newton act at the points A and D respectively and in the same direction perpendicular to the straight line. Another two forces of magnitudes 4 , 7 newton act at the points B and C respectively in the opposite direction of the first two forces. Find the resultants of these forces and the distance between the point of action of the resultant and A

4. $\overline{AB}$ is a rod of length 50 cm. and weighs 20 newton, acts at its midpoint. The rod can rotate easily in a vertical plane about a fixed hinge at its end A. If a couple of moment 250 newton. cm. acts on the rod in a vertical plane. Find the reaction of the hinge and the measure of the inclination angle of the rod to the vertical in the equilibrium position.

5 **In the opposite figure :**



If F = 16 newton , then the moment of F about A equals .... newton.cm.

(a) 320 (b) $160\sqrt{3}$

(c) 160 (d) – 320

6 If $\overrightarrow{F_1} = 6\hat{i} + b\hat{j}$, $\overrightarrow{F_2} = a\hat{i} - 4\hat{j}$, are the two forces of a couple , then a + b = ...

(a) 10 (b) – 10 (c) – 2 (d) 2

7 A uniform rod of length 4 metres and weight 50 kg.wt. rests horizontally on two supports at its ends. If a weight of magnitude 20 kg.wt. is fixed at 1 metre a part from one of its ends , find the reaction of the two supports.

8 ABCD is a rectangle in which AB = 30 cm. , BC = 40 cm. forces of magnitudes 15 , 30 , 15 and 30 dyne act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$ and $\overrightarrow{DA}$ respectively. Prove that this system is equivalent to a couple and find its moment , then find the two forces acting at A and C perpendicular to $\overline{AC}$ such that the system is in equilibrium.

9 If the force $\vec{F} = 2\hat{i} - \hat{j} + 5\hat{k}$ acts at the point A (3 , –1 , 4) , then the component of the moment of $\vec{F}$ about the x-axis equals ....

(a) – 1 (b) 1 (c) – 9 (d) 9

10 The centre of gravity of a system made up of two masses 3 kg. and 5 kg. the distance between them is 8 metres is at a distance of .... metres from the first mass.

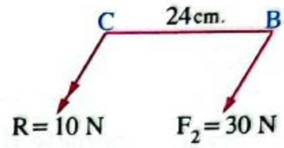
(a) 3 (b) 4 (c) 5 (d) 6

11 ***Answer one of the following items :***

[a] If the force $\vec{F} = 2\hat{i} + 3\hat{j} - \hat{k}$ acts at the point A (1 , – 1 , 4) find the moment of the force $\vec{F}$ about the point B (2 , – 3 , 1) , then determine the length of the perpendicular drawn from the point B on the line of action of the force $\vec{F}$

[b] ABCD is a trapezium in which , m ($\angle$ ABC) = m ($\angle$ BDC) = 90° , $\overline{AD} \parallel \overline{BC}$, AB = 12 cm. , BC = 25 cm. and AD = 9 cm. Forces of magnitudes 75 , F , 50 newton act at $\overrightarrow{DA}$, $\overrightarrow{BA}$ and $\overrightarrow{DB}$ respectively. If the algebraic sum of the moments of these forces about the point C vanishes , find F and the algebraic sum of the moments of these forces about the point E such that E $\in \overline{BC}$, BE = 5 cm.

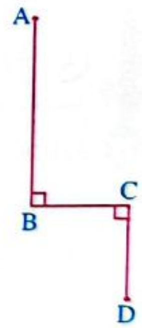
12 **In the opposite figure :**



If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$ and act at A , B respectively such that A $\in \overleftrightarrow{BC}$, BC = 24 cm. , then AB = ... cm.

(a) 6
(b) 12
(c) 18
(d) 48

13 **In the opposite figure :**



ABCD is a wire in which AB = 2 BC = 2 CD = 16 cm.
, then the coordinates of the centre of gravity of the wire about each of $\overleftrightarrow{BC}$ and $\overleftrightarrow{BA}$ respectively is ....

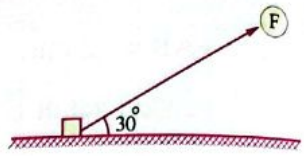
(a) (3 , 3)
(b) (4 , 4)
(c) (3 , 5)
(d) (4 , 8)

14 ***Answer one of the following items :***

[a] A uniform ladder rests in its final equilibrium with its upper end on a rough vertical wall and with its lower end on a horizontal rough ground. If the coefficients of static friction between the ladder and each of the wall and the ground equals $\frac{2}{3}$, $\frac{1}{4}$ respectively , find the measure of the angle of inclination for the ladder to the ground.

[b] A uniform rod of weight (W) is attached at one of its ends by a hinge and the other end is attached by a string joined to a point at the same horizontal plane passing through the hinge such that the measure of the angle of inclination for each of the rod and the string to the horizontal is equal to θ. Prove that the reaction at the hinge is equal to $\frac{W}{4}\sqrt{\cot^2\theta + 9}$

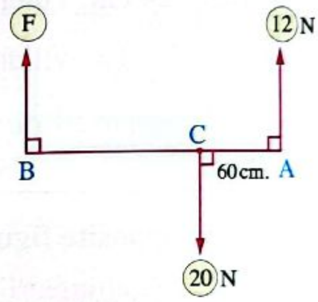
15 **In the opposite figure :**



A body of weight 48 Newton is placed on a rough horizontal plane and the measure of the angle of friction between the body and the plane equals 60°. If a force inclined to the horizontal at an angle of measure 30° acts on the body to make it about to move on the plane , then the magnitude of the force equals .... newton.

(a) 48 (b) 24 (c) 36 (d) 12

16 **In the opposite figure :**



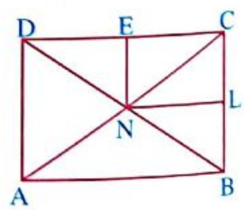
If the system of coplanar forces are equilibrium , then BC = ... cm.

(a) 45 (b) 150
(c) 90 (d) 8

17 A body of weight 80 newton is placed on a rough plane inclined to the horizontal at an angle of measure θ such that $\tan\theta = \frac{3}{4}$ and the coefficient of the static friction between the body and the plane equals μ_s

If a horizontal force of magnitude 160 newton acts on the body to make it about to move upwards the plane , find the value of μ_s

18 **In the opposite figure :**



ABCD is a lamina of a uniform thickness and density in the form of a rectangle in which AB = 12 cm. , BC = 8 cm.

If L , E are the midpoints of $\overline{BC}$, $\overline{CD}$ respectively

, $\overline{AC} \cap \overline{BD} = \{N\}$

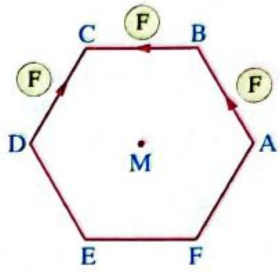
The rectangle NLCE is cut off from the lamina. Find the distance between the centre of gravity of the remaining part of the lamina in this case and both $\overleftrightarrow{AB}$ and $\overleftrightarrow{AD}$

If the lamina is suspended freely from A , find the tangent of the inclination angle of $\overline{AB}$ to the vertical in the equilibrium position.

Answer the following questions :

1 **In the opposite figure :**

ABCDEF is a regular hexagon whose side length is (ℓ) , three equal forces each of magnitude F act at $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$ respectively , then the algebraic sum of the moments of these forces about the point M (the centre of the hexagon) equals .... moment unit.



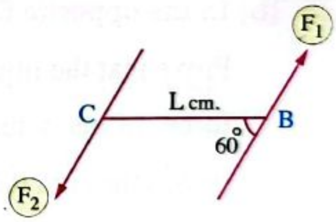
(a) $\frac{3\sqrt{3}}{2} F\ell$ (b) $\frac{\sqrt{3}}{3} F\ell$

(c) $\frac{\sqrt{3}}{2} F\ell$ (d) $\frac{-\sqrt{3}}{2} F\ell$

---

2 **In the opposite figure :**

$F_1 = 7$ newton , the two forces $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ form a couple whose moment equals 210 newton.cm. , then L = ... cm.



(a) 30 (b) $30\sqrt{3}$

(c) $20\sqrt{3}$ (d) $15\sqrt{3}$

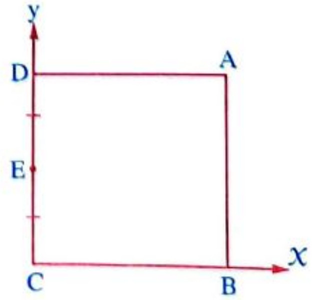
---

3 If the forces $\overrightarrow{F_1} = 2\hat{i} - 4\hat{j}$, $\overrightarrow{F_2} = \hat{i} - 3\hat{j}$, $\overrightarrow{F_3} = -3\hat{i} + 7\hat{j}$ act at the points A(−1 , 1) , B(−2 , 3) , C(0 , 1) respectively , prove that the system of forces is equivalent to a couple and find its moment.

---

4 **In the opposite figure :**

ABCD is a square of side length 40 cm. , masses of magnitudes 5 , 10 and 15 kg. are attached at vertices A , B and C respectively. Another mass of magnitude 20 kg. is attached at E the midpoint of $\overline{CD}$



Identify the distance between the centre of gravity of the system and both $\overleftrightarrow{CB}$ and $\overleftrightarrow{CD}$. If the square is freely suspended from C , find the measure of the angle which $\overline{BC}$ makes with the vertical in the equilibrium position.

5 If the force $\overrightarrow{F} = 7\,\hat{j}$ acts at the point A $(-3\ ,0)$, then the length of the perpendicular segment drawn from the point B $(1\ ,-2)$ to the line of action of the force $\overrightarrow{F}$ equals .... length unit.

(a) 4 (b) 7 (c) 28 (d) 2

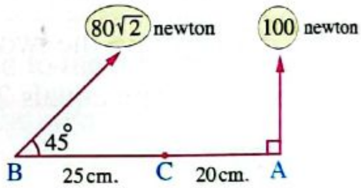
6 The centre of gravity of the next system : $m_1 = 1$ kg. at $(1\ ,0)$, $m_2 = 2$ kg. at $(0\ ,2)$, $m_3 = 3$ kg. at $(1\ ,2)$ is ....

(a) $\left(\frac{-1}{3}\ ,\frac{-1}{3}\right)$ (b) $(2\ ,1)$ (c) $\left(\frac{5}{3}\ ,\frac{2}{3}\right)$ (d) $\left(\frac{2}{3}\ ,\frac{5}{3}\right)$

7 ***Answer one of the following items :***

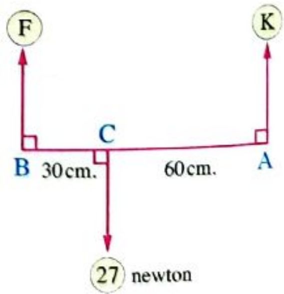
[a] If the force $\overrightarrow{F} = 3\,\hat{i} - 2\,\hat{j} + 4\,\hat{k}$ acts at the point A $(1\ ,0\ ,-1)$, find the moment of the force $\overrightarrow{F}$ about the point B $(2\ ,-1\ ,3)$, then determine the length of the perpendicular segment drawn from the point B on the line of action of the force $\overrightarrow{F}$

[b] In the opposite figure :



Prove that the line of action of the resultant of the two forces of magnitudes 100 newton and $80\sqrt{2}$ newton passes through the point C , then find the magnitude of the moment of the resultant of the forces about the point A

8 **In the opposite figure :**



If the system of coplanar forces are equilibrium , then F = ... newton.

(a) 9

(b) 18

(c) 13.5

(d) 27

9 The centre of gravity of a system made up of two masses 7 kg. and 11 kg. distant 90 cm. from each other is distant .... cm. from the first mass.

(a) 50 (b) 55 (c) 35 (d) 45

10 *Answer one of the following items :*

[a] A uniform rod rests in a vertical plane with its upper end on a smooth vertical wall and with its lower end on a horizontal rough ground. If the coefficients of static friction between the rod and the ground equals $\frac{1}{3}$, find the measure of the angle of inclination for the rod to the ground when it is about to slide.

[b] A uniform rod $\overline{AB}$ of 60 cm. length and weight 8 newton is hinged at its end A to a hinge fixed at a vertical wall. A weight of 6 newton is suspended at a point in the rod distant 40 cm. from the end A. The rod is being kept in a horizontal position by a light string attached at one of its two ends with the end B of the rod while the other end of the string is fixed at a point on the wall distant 80 cm. vertically upwards from A. Find the tension in the string and the reaction of the hinge.

---

11 If μ_s , μ_k are static and kinetic coefficient friction respectively of two bodies touch each other , then ....

(a) $\mu_s = \mu_k$

(b) $\mu_s < \mu_k$

(c) $\mu_s > \mu_k$

(d) there is no relation between them.

---

12 $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two parallel forces , the magnitude of the first equals 10 kg. wt. , and the magnitude of their resultant (R) equals 16 kg. wt. If the distance between $\overrightarrow{F_1}$, $\overrightarrow{R}$ equals 12 cm. , $\overrightarrow{F_1}$ and $\overrightarrow{R}$ work in the same direction , then the distance between the two forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ equals .... cm.

(a) 8 (b) 16 (c) 20 (d) 32

---

13 A body of weight 40 newton is placed on a rough plane inclined to the horizontal at an angle of measure 30°. If a force F acts on the body in the direction of the line of the greatest slope of the plane upwards to make it about to move on the plane upwards. If the coefficient of the static friction between the body and the plane equals $\frac{\sqrt{3}}{2}$, find the value of F

---

14 If the two forces $\overrightarrow{F_1} = 3\hat{i} - \hat{j}$ and $\overrightarrow{F_2} = -9\hat{i} + 3\hat{j}$ act at the two points A (– 1 , 0) and B (1 , 2) respectively , find the resultant of the two forces and its intersection point with $\overleftrightarrow{AB}$

15 A body of weight 40 newton is placed on a rough horizontal plane. If a horizontal force of magnitude 20 newton acts on it to make it about to move, then the magnitude of the resultant reaction force = ... newton.

(a) $40\sqrt{5}$ (b) $20\sqrt{5}$ (c) $\frac{1}{4}\sqrt{5}$ (d) $\frac{1}{2}\sqrt{5}$

---

16 $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces , where $7\overrightarrow{F_1} = 6\overrightarrow{F_2}$ and their resultant at a distance 42 cm. far from the point of action of $\overrightarrow{F_2}$, then the distance between the line of action of the resultant and $\overrightarrow{F_1}$ equals .... cm.

(a) 78 (b) 36 (c) 49 (d) 6

---

17 $\overline{AB}$ is a uniform rod of length 4 metres and weight 10 kg.wt. rests horizontally on two supports the first at A and the second is at a distant 1 metre from B

Identify at which point on the rod a weight of magnitude 50 kg. wt. should be suspended in order that the magnitudes of the pressure on the two supports are equal.

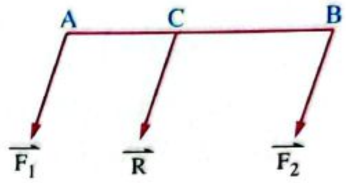
---

18 ABC is a triangle in which AB = BC = 8 cm. , m ($\angle$ ABC) = 120° , forces of magnitudes 12 , 12 , $12\sqrt{3}$ Newton act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CA}$ respectively.

Prove that this system is equivalent to a couple and find its moment.

Answer the following questions :

1 **In the given figure :**



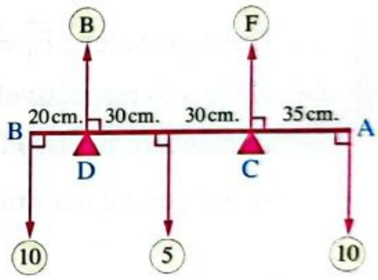
$\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces in the same direction and act at the points A and B respectively , their resultant is $\overrightarrow{R}$ acts at the point $C \in \overline{AB}$.

If $F_1 = 8$ newton , $R = 13$ newton and $AC = 10$ cm. , then AB = ... cm.

(a) 16 (b) 13 (c) 26 (d) 6

---

2 **In the given figure :**



If the rod is light and in horizontal equilibrium , then ....

(a) F = 15 newton , K = 10 newton

(b) F = 10 newton , K = 15 newton

(c) F = 10 newton , K = 10 newton

(d) F = 12.5 newton , K = 12.5 newton

---

3 $\overline{AB}$ is a uniform rod of length 100 cm. and its weight is 20 newton. The rod rests horizontally on two supports , one of them is 30 cm. distant from A and the other is 20 cm. distant from B. Find the magnitude of the pressure on each support. Find also the magnitude of the weight that should be suspended at B so that the rod is about to rotate.

---

4 A fine lamina of uniform density in the form of the rectangle ABCD in which AB = 12 cm. , BC = 8 cm. If L and E are the mid points of $\overline{BC}$, $\overline{CD}$ respectively , $\overline{AC} \cap \overline{BD} = \{N\}$ and the rectangle NLCE is separated , determine the center of gravity of the remaining part consider $\overleftrightarrow{AB}$, $\overleftrightarrow{AD}$ are the coordinate axes.

---

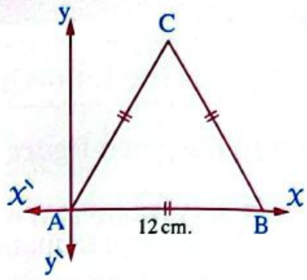
5 The centre of gravity of the two physical particles of weights : 12 newton at (– 20 , 0) and 8 newton at (40 , 0) with respect to the origin point is ....

(a) (0 , 0) (b) (4 , 0) (c) (10 , 0) (d) (36 , 0)

6 The centre of gravity of the following system :

Mass	4 kg.	5 kg.	3 kg.
Position	A	B	C

is ....



(a) $\left(6, 2\sqrt{3}\right)$

(b) $\left(6, 4\sqrt{3}\right)$

(c) $\left(\frac{13}{2}, \frac{3\sqrt{3}}{2}\right)$

(d) $\left(6, 3\sqrt{3}\right)$

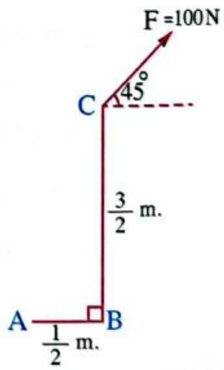
7 ***Answer only one of the following two questions :***

[a] Find the moment about the origin point of the force $\overrightarrow{F} = -2\hat{i} + 3\hat{j} + 5\hat{k}$ which acts at the point A whose position vector with respect to the origin point is $\overrightarrow{r} = \hat{i} - \hat{j} + \hat{k}$, then find the length of the perpendicular drawn from the origin point to the line of action of $\overrightarrow{F}$

[b] The two forces : $\overrightarrow{F_1} = \hat{i} + 2\hat{j}$ and $\overrightarrow{F_2} = m\hat{i} - 4\hat{j}$ act at the two points A (5 , 1) , B (0 , 3) respectively. Determine the value of the constant m such that the sum of moments of the two forces about the origin point vanishes , then find the length of the perpendicular drawn from the origin point to the line of action of the force $\overrightarrow{F_2}$

8 **In the given figure :**

The algebraic measure of the moment of the force $\overrightarrow{F}$ about the point A equals .... newton.m.



(a) $100\sqrt{2}$

(b) $-50\sqrt{2}$

(c) $50\sqrt{2}$

(d) $-75\sqrt{2}$

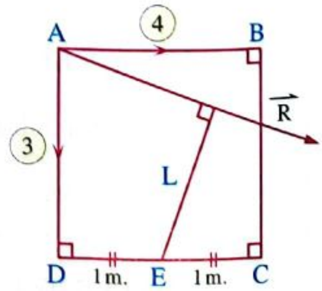
9 **In the given figure :**

ABCD is a square whose side length 2 m.

The two forces 4 , 3 kg.wt.

act along $\overrightarrow{AB}$, $\overrightarrow{AD}$ respectively.

If $\overrightarrow{R}$ is their resultant , L is the length of perpendicular drawn from E to the line of action of $\overrightarrow{R}$, then..............



(a) R = 5 kg.wt , L = 1.5 m.

(b) R = 5 kg.wt , L = 1 m.

(c) R = 5 kg.wt , L = $\sqrt{2}$ m.

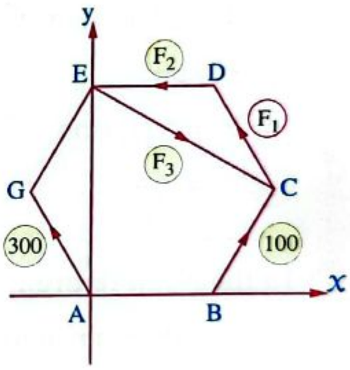
(d) R = 5 kg.wt , L = 1.2 m.

10 $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces where $F_1 = 100$ newton and the magnitude of their resultant is $R = 150$ newton. The distance between the lines of action of first force and the resultant is 75 cm. If $\overrightarrow{F_1}$ and $\overrightarrow{R}$ are in the same direction , determine : the magnitude , the direction and the point of action of the force $\overrightarrow{F_2}$

11 ABCD is a parallelogram in which AB = 18 cm. , BC = 20 cm. and m ($\angle$ A) = 30°
Forces of magnitudes 8 , 6 , 8 and 6 newton act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$ and $\overrightarrow{DA}$ respectively. Prove that the system is equivalent to a couple and find the norm of its moment , then find the magnitude of each of the two forces which act at A and D , perpendicular to $\overline{AD}$ and equivalent to that system.

12 **In the given figure :**

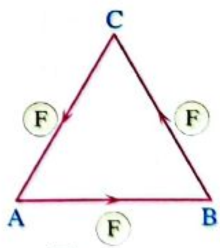
ABCDEG is a uniform hexagon with side length 40 cm.
If the given forces are in equilibrium , then $F_2 =$ .... newton.



(a) 600
(b) $300\sqrt{3}$
(c) 100
(d) 150

13 **In the given figure :**

ABC is an equilateral triangle , of side length L cm.
If forces of equal magnitudes and each of magnitude F newton , act along $\overrightarrow{AB}$, $\overrightarrow{BC}$ and $\overrightarrow{CA}$ respectively , then the moment of the equivalent couple = ... newton. cm.



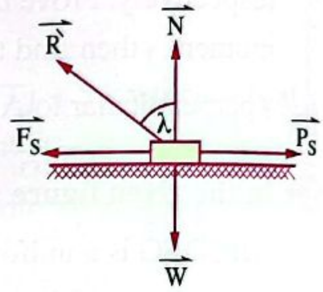
(a) $L^2 F \frac{\sqrt{3}}{2}$ (b) $2\,LF\sqrt{3}$ (c) $LF\sqrt{3}$ (d) $LF\frac{\sqrt{3}}{2}$

14 ***Answer only one of the following two questions :***

[a] $\overline{AB}$ is a uniform rod of length of 200 cm. and of the weight 10 newton. its end A is connected to a hinge fixed in a vertical wall and it carries at its end B a weight equals its weight. The rod is kept in equilibrium horizontally by means of a string one of its ends is connected to a point of the rod at 150 cm. from A and its other end is connected to a point on the wall lying vertically above A. If the string inclines to the horizontal at an angle of measure 30° , find the tension in the string and the reaction of the hinge.

[b] $\overline{AB}$ is a uniform ladder of weight 30 kg.wt. and of length 5 m. It rests in a vertical plane with its end A on a vertical smooth wall and with its end B on a rough horizontal ground , the static coefficient of friction between them equals $\frac{2}{5}$ If the ladder inclines at an angle of measure 60° to the horizontal , find the greatest distance that a man of weight 80 kg.wt. , could ascend on the ladder without the ladder slides.

15 **In the given figure :**



If the friction is limiting , $N = 5\sqrt{3}$ newton , $F_s = 5$ newton , then all of the following statements are true except :

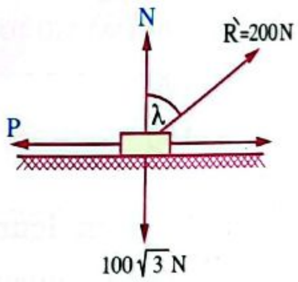
(a) $\grave{R} = 10$ newton

(b) $\lambda = 60°$

(c) $P_s = 5$ newton

(d) $\mu_s = \frac{1}{\sqrt{3}}$

16 **In the given figure :**



If the body is about to move , then ....

(a) P = 200 newton , $\lambda = 30°$

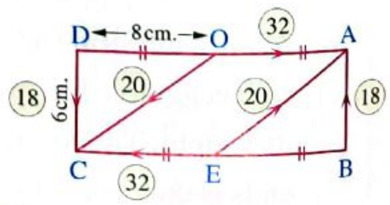
(b) $P = 100\sqrt{3}$ newton , $\lambda = 30°$

(c) P = 100 newton , $\lambda = 30°$

(d) P = 100 newton , $\lambda = 60°$

17 A body of mass 2 kg. is placed on a rough plane inclined to the horizontal at an angle of measure 30°. A horizontal force of magnitude 20 newton acts on the body so that the body becomes about to move up the plane. Determine the coefficient of the static friction between the body and the plane.

18 **In the given figure :**



ABCD is a rectangle in which E and O are the midpoints of $\overline{BC}$ and $\overline{AD}$ respectively and AB = 6 cm. , BC = 16 cm. If the acting forces are measured in newton and their magnitudes and directions are as given in the figure , prove that the system is in equilibrium.

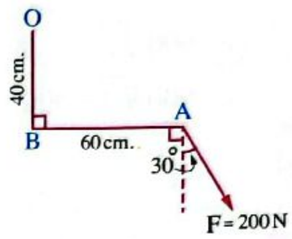
Egypt exams

2^{nd} session 2019

Answer the following questions :

1 **In the given figure :**

The algebraic measure of the moment of the force $\vec{F}$ about point O equals ·············· newton.cm.

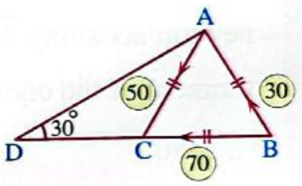


(a) $6000\sqrt{3} - 4000$ (b) $-6000\sqrt{3}$

(c) $-2000\sqrt{3}$ (d) $4000 - 6000\sqrt{3}$

2 **In the given figure :**

$AB = BC = CA = 12$ cm. , $m(\angle ADB) = 30°$. If the forces of magnitudes 30 , 50 and 70 newton act along $\overrightarrow{BA}$, $\overrightarrow{AC}$ and $\overrightarrow{BC}$ respectively , then the sum of moments of the forces about point D = ·············· newton.cm.



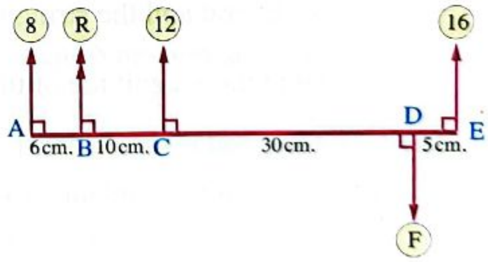
(a) $60\sqrt{3}$ (b) $-60\sqrt{3}$

(c) $360\sqrt{3}$ (d) $-300\sqrt{3}$

3 **In the given figure :**

The resultant of the four forces 8 , 12 , 16 and F newton acts at point B.

Find the value of F.



4 ABCD is a square of side length 20 cm. Forces of magnitudes 6 , 7 , 6 and 7 newton act along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$ and $\overrightarrow{AD}$ respectively. Two other forces each of magnitude $4\sqrt{2}$ newton act at A and C in the directions $\overrightarrow{BD}$, $\overrightarrow{DB}$ respectively. **Find :**

[a] The norm of the moment of the resultant couple.

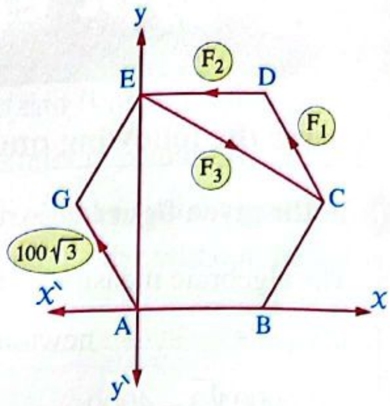
[b] The magnitude and the direction of two forces acting at B , D parallel to $\overleftrightarrow{AC}$ for the system to be in equilibrium.

5 **In the given figure :**

ABCDEG is a regular hexagon of side length 40 cm.

If the given forces are in equilibrium

, then $F_3 =$ .... N.



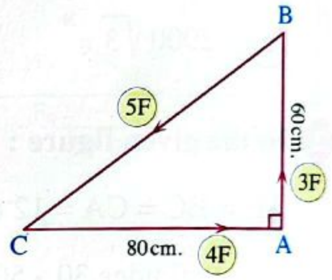
(a) $600\sqrt{3}$ (b) 150

(c) $600\sqrt{3} - 300$ (d) 600

6 **In the given figure :**

ABC is a right-angled triangle at A , in which : AB = 60 cm.

and AC = 80 cm. If forces of magnitudes : 3 F , 5 F and 4 F newton act along $\overrightarrow{AB}$, $\overrightarrow{BC}$ and $\overrightarrow{CA}$ respectively , then the moment of the equivalent couple = ... newton.cm.



(a) 480 F (b) 240 F (c) 120 F (d) $\frac{96000}{F}$

7 ***Answer only one of the following two questions :***

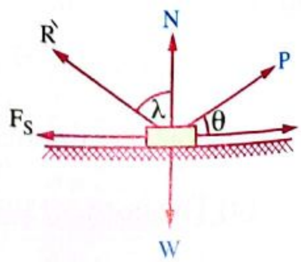
[a] $\overline{AB}$ is a uniform rod of weight W newton. Its end A is attached to a hinge fixed in a vertical wall and its other end B is attached to a string tied in a point in the same horizontal plane passing by the hinge so that the measure of the angle of inclination of each of the rod and the string to the horizontal equals 30°.

Prove that the magnitude of the reaction of the hinge equals $\frac{\sqrt{3}}{2}$ W.

[b] A uniform rod rests in a vertical plane with its upper end on a smooth vertical wall and with its lower end on a rough horizontal plane , the coefficient of static friction between it and the rod is $\frac{1}{3}$. Find the measure of the angle of inclination of the rod to the horizontal when it is about to slide.

8 **In the given figure :**

If the body is in equilibrium on a horizontal rough plane and acted upon by a force $\overrightarrow{P}$ inclined by an angle of measure (θ) to the horizontal , and if the friction is limiting , then all the following statements are true except :

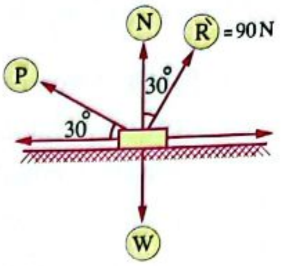


(a) $F_s = P\cos\theta$ (b) $\grave{R} = \frac{P\cos\theta}{\sin\lambda}$

(c) $W = \frac{P\cos(\theta - \lambda)}{\sin\lambda}$ (d) $W = P\sin\theta$

9 **In the given figure :**

If the body is just about to move , then ....



(a) $P = 30\sqrt{3}$ newton , $W = 45\sqrt{3}$ newton

(b) $P = 30\sqrt{3}$ newton , $W = 15\sqrt{3}$ newton

(c) $P = 30\sqrt{3}$ newton , $W = 60$ newton

(d) $P = 30\sqrt{3}$ newton , $W = 60\sqrt{3}$ newton

---

10 A body of weight 20 kg.wt is placed on a rough plane inclined to the horizontal at an angle of cosine $\frac{4}{5}$. The body is pulled by a horizontal force which lies in the vertical plane passing by the line of greatest slope of the plane and makes the body about to move up the plane. If the coefficient of static friction between the body and the plane equals $\frac{1}{2}$, find the magnitude of the tension force.

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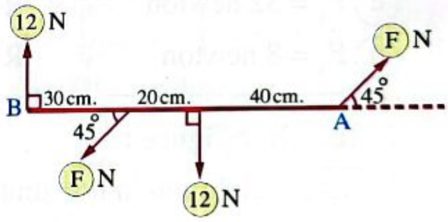
11 **In the given figure :**

Two coplanar couples act on the light rod $\overline{AB}$ whose length is 90 cm. Find the value of F which makes the rod to be in equilibrium.



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12 The centre of gravity of the two physical particles of weights 6 newton at (– 10 , 0) , and 4 newton at (20 , 0) with respect to the origin point is ....

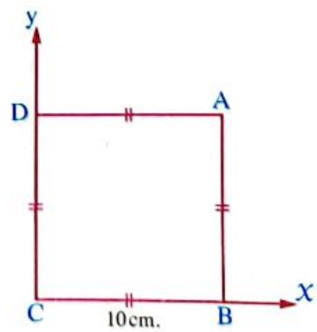
(a) (18 , 0) (b) (5 , 0) (c) (2 , 0) (d) (0 , 0)

---

13 The centre of gravity of the following system :

Mass	20 gm.	30 gm.	10 gm.	40 gm.
Position	A	B	C	D

is ....



(a) (5 , 5)

(b) (6 , 5)

(c) (5 , 6)

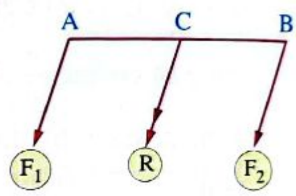
(d) (6 , 3)

14 *Answer only one of the following two questions :*

[a] If the force $\overrightarrow{F} = m\,\hat{i} + 4\,\hat{j} - 2\,\hat{k}$ acts at point A whose position vector with respect to the origin point is $\overrightarrow{r} = (1, 2, 2)$ and the component of the moment of the force $\overrightarrow{F}$ about the y-axis is equal to 10 moment units, find the value of m, then find the length of the perpendicular drawn from the origin point to the line of action of $\overrightarrow{F}$

[b] The force $\overrightarrow{F} = m\,\hat{i} - 5\,\hat{j}$ acts at point A (6, 3). If its moment vector about point B (8, – 1) equals $-2\,\hat{k}$, find the value of the constant m, then find the length of the perpendicular drawn from the point B to the line of action of $\overrightarrow{F}$

15 **In the given figure :**



$\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two like parallel forces acting at A and B respectively, their resultant is $\overrightarrow{R}$ and acting at point $C \in \overline{AB}$. If $F_2 = 6$ newton, AC = 24 cm. and AB = 56 cm., then ....

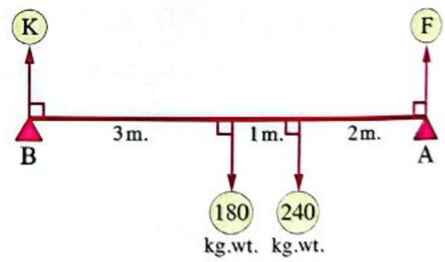
(a) $F_1 = 8$ newton , $R = 14$ newton

(b) $F_2 = 24$ newton , $R = 32$ newton

(c) $F_1 = 32$ newton , $R = 38$ newton

(d) $F_1 = 8$ newton , $R = 2$ newton

16 **In the given figure :**



If $\overline{AB}$ is a light rod in horizontal equilibrium, then ....

(a) F = 170 gm.wt. , k = 250 gm.wt.

(b) F = 240 gm.wt. , k = 180 gm.wt.

(c) F = 250 gm.wt. , k = 170 gm.wt.

(d) F = 210 gm.wt. , k = 210 gm.wt.

17 $\overline{AB}$ is a non-uniform rod of length 100 cm., rests horizontally on two supports at C, D, where AC = 20 cm., BD = 10 cm. If the greatest weight could be suspended at A is 5 kg.wt. and the greatest weight could be suspended at B is 4 kg.wt. find the weight of the rod and determine its point of action.

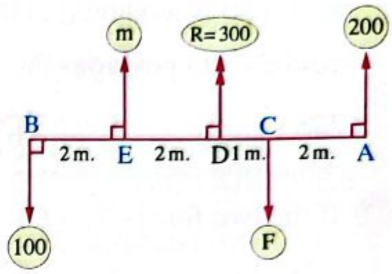
18 A fine lamina of uniform density in the form of an equilateral triangle ABC whose side length is $12\sqrt{3}$, M is the point of intersection of its medians. If the triangle MBC is separated, determine the center of gravity of the remaining part consider $\overrightarrow{BC}$ in the positive direction of X-axis and the perpendicular to it at B in the positive direction of y-axis.

Answer the following questions :

1 **In the given figure :**

If all forces are parallel and perpendicular to $\overline{AB}$ and the resultant of these forces $R = 300$ newton and acts vertically upwards

Then the value of $F =$ .... newton.



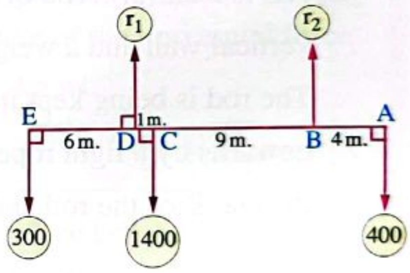
(a) 100 (b) 200 (c) 300 (d) 400

---

2 **In the given figure :**

If the system of forces is equilibrium

, then $r_2 =$ .... newton.



(a) 1580 (b) 1050

(c) 700 (d) 520

---

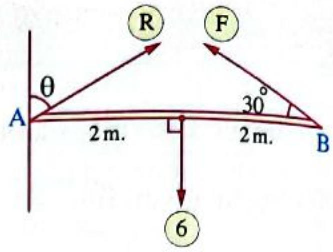
3 A , B , C , D are four different points lie in the same straight line such that $AB = BC = CD = 30$ cm., the two forces of magnitudes 8 , 9 newton act at the two points A and D respectively in the same direction perpendicular to $\overleftrightarrow{AD}$, also the two force of magnitudes 4 , 7 newton act at the two points B and C respectively in a direction opposite to the direction of the first two forces. Find the resultant of this system of forces.

---

4 $\overline{AB}$ is a uniform rod of length 80 cm. and its weight acts at its midpoint, the rod rests in a horizontal position on two supports at its two ends, two weights are suspended on it such that the magnitude of one of them equals 5 newton and acts at a distance 60 cm. from A, the other of magnitude 20 newton and acts at a distance 5 cm. from B. If the magnitude of the reaction of the support at B equals twice the magnitude of the reaction of the support at A , find the magnitude of the weight of the rod and the magnitudes of the reactions of the two supports at A and B

5 **In the given figure :**

$\overline{AB}$ is a uniform rod of length 4 meter and weight 6 kg.wt. attached to a hinge at its end A. If a force of magnitude F acts at its end B as shown in the figure to keep it horizontally in an equilibrium position, then r = ... kg.wt.



(a) 12 (b) $6\sqrt{3}$ (c) 6 (d) $3\sqrt{3}$

6 If the two forces $\overrightarrow{F_1} = 6\hat{i} - a\hat{j}$, $\overrightarrow{F_2} = b\hat{i} + 8\hat{j}$ form a couple, then 3 a + 4 b = ...

(a) – 24 (b) zero (c) 24 (d) 48

7 ***Answer only one of the following two questions :***

[a] $\overline{AB}$ is a uniform rod of weight 4 newton is hanged at its end A to a hinge fixed at a vertical wall and a weight of magnitude 2 newton is suspended at its end B.
The rod is being kept in a position inclined to the horizontal at an angle of measure 30° upwards by a light rope perpendicular to the rod such that one of its ends is attached to the end B of the rod and the other end to point C of the wall lying vertically above A

Find :

(1) The magnitude of tension in the rope.

(2) The magnitude of the reaction force of the hinge at A

[b] $\overline{AB}$ is a uniform ladder of weight (W) rests with its end A on a horizontal rough ground and with its other end B on a smooth vertical wall, known that the static coefficient friction between the ladder and the ground equals $\frac{2}{3}$. If a horizontal force F acts at the end A of the ladder to make it about to move towards the wall when the ladder inclines to the horizontal plane at an angle of measure 45°
Find the value of (F) in terms of (W)

8 If $\overrightarrow{F} = 6\hat{i} - 8\hat{j}$ acts at the origin point, then the moment of the force $\overrightarrow{F}$ about the point A (2 , – 5) equals ....

(a) $14\hat{k}$ (b) $-14\hat{k}$ (c) $52\hat{k}$ (d) $-52\hat{k}$

9 If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$ and their resultant is $\overrightarrow{R}$ such that $\overrightarrow{F_1} = 9\hat{i} - 12\hat{j}$ and $\overrightarrow{R} = -2\overrightarrow{F_2}$, then $\overrightarrow{F_2}$ = ...

(a) $-9\hat{i} + 12\hat{j}$ (b) $-18\hat{i} + 24\hat{j}$ (c) $3\hat{i} - 4\hat{j}$ (d) $-3\hat{i} + 4\hat{j}$

10 ***Answer only one of the following two questions :***

[a] If the moment of the force

$\vec{F} = 2\hat{i} + 3\hat{j} - \hat{k}$ about the origin point (O) is $\overrightarrow{M_O} = -5\hat{i} + 3\hat{j} - \hat{k}$ and the line of action of the force passes through the point (m , 2 , n).

Find the value of each of m and n , then find the length of the perpendicular drawn from the origin point to the line of action of the force.

[b] ABCD is a right trapezium at B , $\overline{AD} \parallel \overline{BC}$, AB = 8 cm. , BC = 15 cm. , AD = 9 cm.

Forces of magnitudes F , 44 , 68 gm.wt act along $\overrightarrow{DA}$, $\overrightarrow{DC}$, $\overrightarrow{AC}$ respectively, if the line of action of the resultant of these forces passes through the point B

Find the value of F

---

11 A body of weight 30 kg.wt is placed on a horizontal rough plane and the angle of friction between the body and the plane equals 30° , then the magnitude of the horizontal force acts on the body and makes it about to move equals .... kg.wt.

(a) 10 (b) $10\sqrt{3}$ (c) 20 (d) $20\sqrt{3}$

---

12 If a body is about to slide under the action of its weight when placed on a rough plane inclined to the horizontal at an angle whose measure equals 30° , then the static coefficient friction between the body and the plane equals ....

(a) $\frac{\sqrt{3}}{2}$ (b) $\sqrt{3}$ (c) $\frac{\sqrt{3}}{3}$ (d) $\frac{1}{2}$

---

13 A body of weight 60 newton is placed on a plane inclined to the horizontal at an angle whose tangent is $\frac{12}{5}$ and the static coefficient friction between the body and the plane equals $\frac{2}{3}$

Find the magnitude of the horizontal force that acts on the body and lies in the vertical plane which passes through the line of the greatest slope of the plane to prevent the body from sliding.

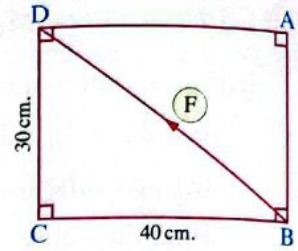
---

14 A uniform rod of length 40 cm. and weight 2.4 kg.wt acts at its midpoint. The rod can rotate easily in a vertical plane about a fixed hinge at one of its end. If the rod is acted by a couple whose moment is 24 kg.wt.cm. and in a direction perpendicular to the vertical plane in which the rod can rotate in.

Determine the magnitude and the direction of the reaction of the hinge and the measure of the inclination angle of the rod to the vertical in the equilibrium position.

15 **In the given figure :**

If F = 25 dyne, then the algebraic measure of the moment of the force $\overrightarrow{F}$ about point A equals .... Dyne. cm.



(a) – 600
(b) 600
(c) 750
(d) 1000

---

16 If $\overrightarrow{F} = 3\hat{i} - 2\hat{j}$, A (– 1, 2), the moment of $\overrightarrow{F}$ about A is $\overrightarrow{M_A} = 9\hat{k}$, the moment of $\overrightarrow{F}$ about B is $\overrightarrow{M_B} = 9\hat{k}$, then the coordinates of the point B can be represented by one of the following ordered pairs except ....

(a) (5, – 2)
(b) (2, 0)
(c) (– 8, 4)
(d) (8, – 4)

---

17 Two parallel forces, the smaller one is of magnitude 30 dyne and acts at the end A of a light rod $\overline{AB}$ and the greater force acts at the other end B of the rod, if the magnitude of their resultant is 10 dyne and is 90 cm. distance from the end B.

Find the length of the rod.

---

18 ABCD is a rectangle in which AB = 30 cm., BC = 40 cm., forces of magnitudes 1, 2, 4, 6, 5 gm.wt act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DA}$, $\overrightarrow{AC}$ respectively.

Prove that the system of forces is equivalent to a couple and find the magnitude of its moment.

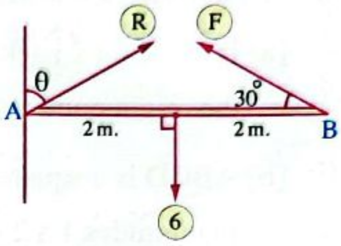
Egypt exams

2nd session 2020

Answer the following questions :

1 **In the given figure :**

$\overline{AB}$ is a uniform rod of length 4 metre and weight 6 kg.wt. attached to a hinge at its end A.
If a force of magnitude F acts at its end B as shown in the figure to keep it horizontally in an equilibrium position , then $\theta =$ .... °



ⓐ 30 ⓑ 60 ⓒ 15 ⓓ 45

---

2 If the two forces $\overrightarrow{F_1} = 4\hat{i} + a\hat{j} + 5\hat{k}$, $\overrightarrow{F_2} = b\hat{i} - 8\hat{j} + c\hat{k}$ form a couple , then $a + b + c =$ ....

ⓐ 4 ⓑ 3 ⓒ −9 ⓓ −1

---

3 ***Answer only one of the following two questions :***

[a] $\overline{AB}$ is a uniform rod of weight 4 newton is hanged at its end A to a hinge fixed at a vertical wall and a weight of magnitude 2 newton is suspended at its end B. The rod is being kept in a position inclined to the horizontal upwards at an angle of measure 30° by a light rope whose length equals to length of the rod such that one of its ends is attached to the end B of the rod and the other end to point C of the wall lying vertically above A

Find :

(1) The magnitude of the tension in the rope.

(2) The magnitude of the reaction force of the hinge at A

[b] A uniform ladder of length 6 meter and weight 10 kg.wt rests with one of its two ends on a smooth vertical wall and with its other end on a horizontal rough ground known that the static coefficient friction between the ladder and the ground equals $\frac{1}{2}$
Prove that the ladder is in limiting equilibrium when it inclines to the vertical at an angle of measure 45°

---

4 If $\vec{F} = 3\hat{i} - 5\hat{j}$ acts at the point A (6 , −2) , then the moment of the force $\vec{F}$ about the origin point equals ....

ⓐ $28\hat{k}$ ⓑ $-28\hat{k}$ ⓒ $24\hat{k}$ ⓓ $-24\hat{k}$

5. If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$ and $\overrightarrow{F_1} = -6\,\hat{i} + 10\,\hat{j}$ and $\overrightarrow{F_2} = -2\,\overrightarrow{F_1}$, then their resultant $\overrightarrow{R} =$ ....

(a) $12\,\hat{i} - 20\,\hat{j}$ (b) $-12\,\hat{i} + 20\,\hat{j}$ (c) $6\,\hat{i} - 10\,\hat{j}$ (d) $-6\,\hat{i} + 10\,\hat{j}$

6. ***Answer only one of the following two questions :***

[a] If $\overrightarrow{F} = 2\,\hat{i} + \ell\,\hat{j} - \hat{k}$ acts at the point A (4 , – 2 , 0) and the moment of the force $\overrightarrow{F}$ about the origin point is $\overrightarrow{M_O} = 2\,\hat{i} + 4\,\hat{j} + 16\,\hat{k}$. Find the value of ℓ

[b] ABCD is a square of side length 60 cm. , $E \in \overline{BC}$ such that BE = 10 cm. , forces of magnitudes 1 , 2 , 3 , 4 , F newton act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DA}$, $\overrightarrow{AC}$ respectively If the line of action of the resultant of these forces passes through the point E , find the value of F

7. If a body of weight 50 newton rests on a rough plane inclines to the horizontal at an angle whose tangent = $\frac{3}{4}$ and the magnitude of the least force acts in the direction of the plane upward and preserves the equilibrium of the body equals 20 newton , then the static coefficient friction between the body and the plane equals ....

(a) $\frac{4}{5}$ (b) $\frac{1}{2}$ (c) $\frac{3}{4}$ (d) $\frac{1}{4}$

8. A body of mass 4 kg. is placed on a horizontal rough plane and the static coefficient friction between the body and the plane equals 0.8 . If a horizontal force of magnitude 19 newton acts on the body, then the magnitude of the friction force equals .... newton.

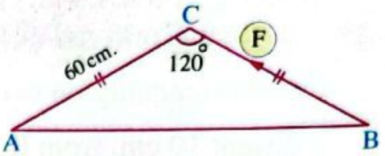
(a) 31.36 (b) 18 (c) 19 (d) 9.8

9. A body of weight 30 newton is placed on a rough inclined plane , it is notice that the body is about to slide when the plane inclined to the horizontal at an angle of measure 30°.

If the inclination of the plane to the horizontal is increased to 60° , then find the magnitude of the force which acts on the body parallel to the line of the greatest slope of the plane and make it about to move upwards the plane.

10. ABCD is a fine lamina in the form of a square whose side length is 50 cm. and of weight 300 gm.wt. acts at the center of the square. The lamina is suspended by a pin in a vertical plane from a small hole close to vertex A such that its plane is vertical. If a couple of magnitude 7500 gm.wt.cm. acts on the plane of the lamina , find the measure of the angle of inclination of the diagonal $\overline{AC}$ to the vertical in the equilibrium position.

11 **In the given figure :**

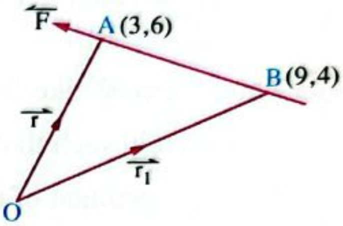


If F = 20 dyne , then the algebraic measure of the moment of the force $\vec{F}$ about A equals .... Dyne. cm.

(a) 1200 (b) 600 (c) $600\sqrt{3}$ (d) $-600\sqrt{3}$

---

12 **In the given figure :**



If A (3 , 6) and B (9 , 4) are two points on the line of action of the force $\vec{F}$, $\vec{r}$ is the position vector of point A , $\vec{r_1}$ is the position vector of point B , then all of the following statements are correct except ....

(a) $\overrightarrow{M_O} = (3 , 6) \times \vec{F}$

(b) $\overrightarrow{M_O} = [\, \vec{r} + \overrightarrow{BA} \,] \times \vec{F}$

(c) $\overrightarrow{M_O} = (9 , 4) \times \vec{F}$

(d) $\overrightarrow{M_O} = [\, \vec{r} + \overrightarrow{AB} \,] \times \vec{F}$

---

13 If $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ are two unlike parallel forces act at the two points A , B respectively such that AB = 12.5 cm. , F_1 = 80 dyne , F_2 = 30 dyne , find the resultant of the two forces.

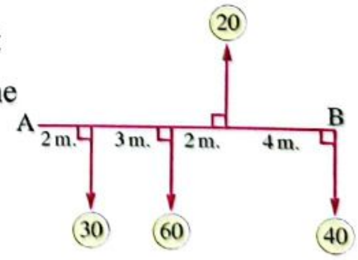
---

14 ABCD is a rectangle in which AB = 30 cm. , BC = 40 cm. , forces of magnitudes 15 , 30 , 15 , 30 gm.wt. act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{DA}$ respectively.

Prove that this system of forces is equivalent to a couple and find its moment , then find two forces acting at A and C perpendicular to $\overline{AC}$ such that the system is in equilibrium.

---

15 **In the given figure :**



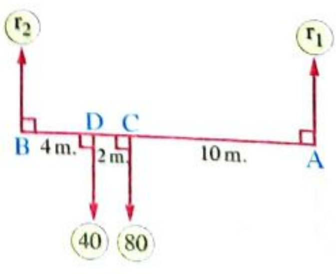
If all forces are parallel and perpendicular to $\overline{AB}$, then the point of action of the resultant is at a distance .... metres from the point A.

(a) 7 (b) 5

(c) 6 (d) 5.5

---

16 **In the opposite figure :**



If the system of forces is equilibrium , then r_1 = ... newton.

(a) 20 (b) 40

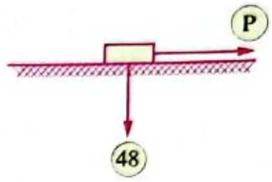
(c) 60 (d) 80

17. $\overline{AB}$ is a uniform rod of length 80 cm. and weight 20 newton acts at its midpoint. If the rod rests horizontally on two supports one of them at a distant 20 cm. from A and the other at a distant 10 cm. from B , find the magnitude of the pressure on each support.
What is the magnitude of the weight that must be suspended from the end B so that the rod is about to rotate ? What is the magnitude of the pressure on the support near B then ?

18. Three vertical like forces of magnitudes 10 , 14 , 18 newton act at the points A , B , C respectively such that $B \in \overline{AC}$, AB = 60 cm. , BC = 80 cm.
Find the resultant of this system of forces.

Answer the following questions :

1 **In the opposite figure :**



A body of weight 48 kg.wt. is placed on a rough horizontal plane , a horizontal force of magnitude 4 kg.wt. acts on the body.

If the coefficient of static friction between the body and the plane = $\frac{2}{3}$, then the ratio between the friction force in this case and the limiting friction force = ...

(a) $\frac{1}{8}$ (b) $\frac{1}{12}$ (c) $\frac{3}{2}$ (d) 8

2 A body of weight 10 newton is placed on a horizontal rough plane , and the coefficient of the static friction between the body and the plane = $\frac{1}{\sqrt{5}}$. If the body is pulled by a horizontal force , then the magnitude of the static friction force $\in$ ....

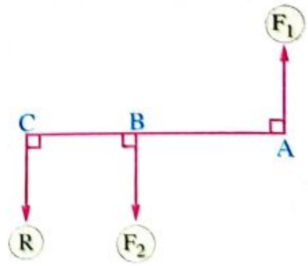
(a) $]0 , 2\sqrt{5}[$ (b) $[0 , 2\sqrt{5}[$

(c) $]0 , 2\sqrt{5}]$ (d) $[0 , 2\sqrt{5}]$

3 If the line of action of the force $\vec{F} = \ell \hat{i} + 5 \hat{j}$ passes through the two points A (2 , 3) and B (4 , 5) , then ℓ = ...

(a) 4 (b) 5 (c) 3 (d) 2

4 **In the opposite figure :**



$\vec{F_1}$, $\vec{F_2}$ are two parallel forces act at the two points A , B

If their resultant acts at the point C , where $C \in \overrightarrow{AB}$

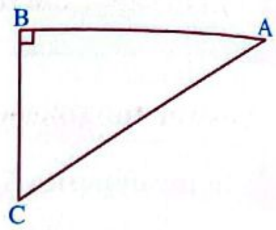
, AB : AC = 4 : 7 and the magnitude of their resultant is 20 gm.wt. , then F_1 = ... gm.wt.

(a) 35 (b) 20 (c) 25 (d) 15

5 If the force $\vec{F_1} = (3 , -1)$ acts at the point A (1 , 2) , $\vec{F_2}$ acts at the point B (− 1 , 1) and the two forces form a couple , then the algebraic measure of the moment of the couple = ... moment unit.

(a) 5 (b) 2 (c) − 5 (d) − 2

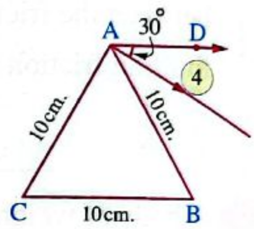
6 **In the opposite figure :**



A fine lamina of a uniform thickness and density in the form of a right-angled triangle at B and of weight 30 kg.wt. where AB = 9 cm. , BC = 6 cm. the lamina is suspended in a pin at a small hole near to the vertex B , a couple in its plane acted on it to make it in equilibrium when $\overline{AB}$ is horizontal , then the algebraic measure of the moment of the couple = ... kg.wt.cm.

(a) 135 (b) – 90 (c) – 135 (d) 90

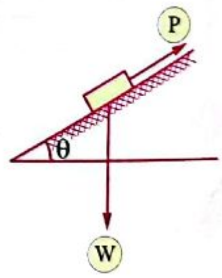
7 **In the opposite figure :**



ABC is an equilateral triangle of side length 10 cm. , a force of magnitude 4 newton acts at the point A in direction makes an angle of measure 30° with $\overline{AD}$ where $\overline{AD}$ // $\overline{BC}$, then the algebraic measure of the moment of the force about B = ... newton.cm.

(a) 20 (b) – 20 (c) 40 (d) – 40

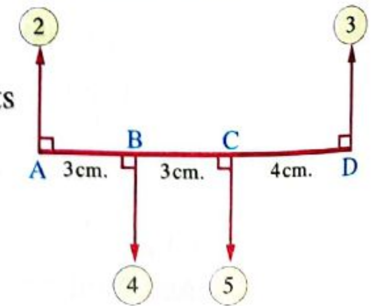
8 **In the opposite figure :**



A body of weight (W) newton is placed on a rough plane inclined to the horizontal with an angle of measure θ. If a force $\vec{P}$ in the direction of the line of the greatest slope of the plane upward acts on the body to make it about to move upwards the plane where the measure of the angle of friction is θ , then the magnitude of the resultant reaction force $\vec{R}$ = ... newton.

(a) W sin θ (b) W cos θ (c) W tan θ (d) W

9 **In the opposite figure :**



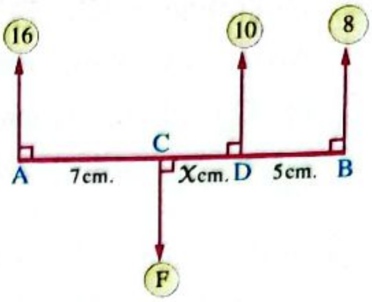
The force of magnitudes 2 , 4 , 5 and 3 newton act at the points A , B , C and D respectively , where CD = 4 cm. , BC = AB = 3 cm. If their resultant acts at the point M where M $\in \overline{AD}$, then DM = ... cm.

(a) 3 (b) 7

(c) 4 (d) 3.5

10 **In the opposite figure :**

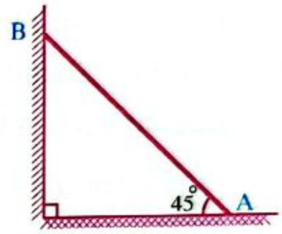
$\overline{AB}$ is a light rod of negligible weight is in equilibrium position horizontally under the action of the forces shown on the figure , where the forces are measured in newton , then X = ... cm.



(a) 8 (b) 5
(c) 7 (d) 4

11 **In the opposite figure :**

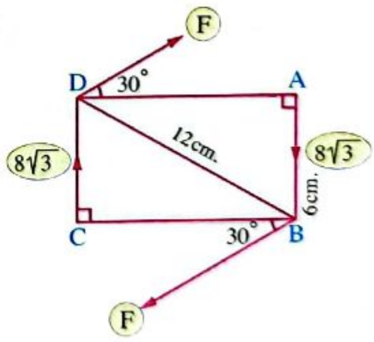
$\overline{AB}$ is a non-uniform ladder of length 4 metre and weight 200 newton. rests with its end A on a rough horizontal ground , the coefficient of static friction between them is $\frac{3}{5}$ and its end B rests against a smooth vertical wall. If the ladder is about to slide when it inclined to the horizontal by an angle of measure 45° , then the point of action of its weight is at a distance .... cm. from A.



(a) 120 (b) 200 (c) 240 (d) 100

12 **In the opposite figure :**

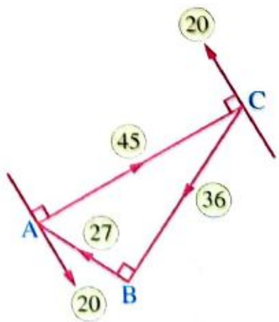
ABCD is a rectangle in which AB = 6 cm. and BD = 12 cm. , the shown forces act on it , if the couple formed from the two forces $8\sqrt{3}$, $8\sqrt{3}$ gm.wt. is equivalent to the couple formed from the two forces F , F gm.wt. , then F = ... gm.wt.



(a) 8 (b) $4\sqrt{3}$
(c) 4 (d) $8\sqrt{3}$

13 **In the opposite figure :**

ABC is a right-angled triangle at B in which AB = 9 cm. , BC = 12 cm. , forces of magnitudes 27 , 45 and 36 newton act in $\overrightarrow{BA}$, $\overrightarrow{AC}$, $\overrightarrow{CB}$ respectively and the forces 20 , 20 newton act at A , C in directions perpendicular to $\overline{AC}$ as shown in the figure. If the system is equivalent to a couple , then the norm of moment of the resultant couple = ... newton.cm.

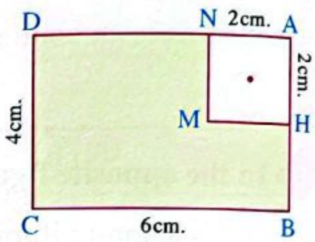


(a) 24 (b) 624 (c) 48 (d) 948

14 Two masses m kg. , 14 kg. are placed at the two points A and B respectively where AB = 20 m. , if the centre of gravity of the two masses acts at the point C where $C \in \overline{AB}$ and CB = 6 m. , then m = ... kg.

(a) 7 (b) 8 (c) 14 (d) 6

15 **In the opposite figure :**



A fine lamina of a uniform thickness and density in the form of a rectangle ABCD whose dimensions are 6 cm. 4 cm. if the square AHMN of side length 2 cm. is cut off as shown in the figure , then the distance between the centre of gravity of the remaining part and each of $\overleftrightarrow{CD}$, $\overleftrightarrow{CB}$ respectively is ....

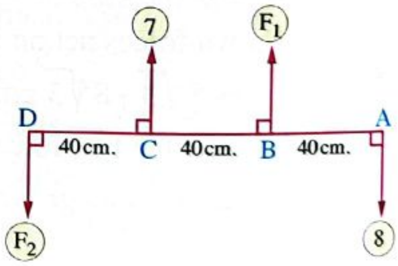
(a) 2.6 cm. , 2.4 cm. (b) 2.6 cm. , 1.8 cm.

(c) 1.8 cm. , 2.6 cm. (d) 2.4 cm. , 2.6 cm.

16 If the force $\vec{F} = \hat{i} - 2\hat{j} + 4\hat{k}$ acts at the point B where B lies on y-axis. If the norm of the moment of $\vec{F}$ about the origin point $= \sqrt{85}$ moment unit , then the y-coordinate of the point B = ...

(a) ± 2.5 (b) $\pm\sqrt{3}$ (c) $\pm\sqrt{5}$ (d) ± 5

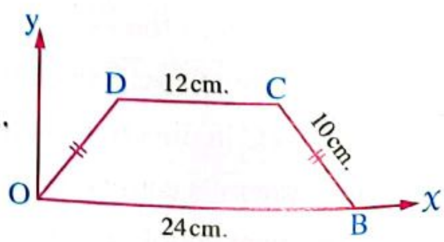
17 **In the opposite figure :**



A , B , C and D are four points lying on the same horizontal straight line such that AB = BC = CD = 40 cm. the parallel forces of magnitudes 8 , F_1 , 7 and F_2 newton act as shown in the figure. If the magnitude of their resultant = 6 newton and acts vertically downward at the point M where M is the midpoint of $\overline{AD}$, then $F_1 + F_2$ = ... newton.

(a) 12 (b) 10 (c) 13 (d) 16

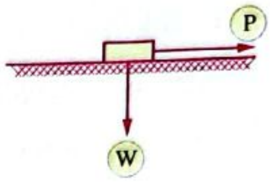
18 **In the opposite figure :**



A wire of a uniform thickness and density in the shape of trapezium OBCD in which $\overline{CD} \mathbin{/\mkern-6mu/} \overline{BO}$, OD = BC = 10 cm. , CD = 12 cm. , OB = 24 cm. , then the center of gravity of the wire is ....

(a) $\left(12 , \frac{22}{7}\right)$ (b) $\left(\frac{22}{7} , 12\right)$ (c) $\left(10 , \frac{22}{7}\right)$ (d) $\left(\frac{22}{7} , 10\right)$

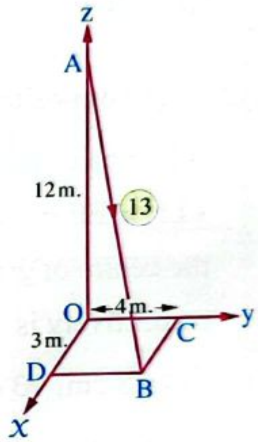
19 **In the opposite figure :**



A body of weight (W) newton placed on a rough horizontal plane. A horizontal force of magnitude P newton acts on the body trying to move it. If the resultant reaction in newton $\in]6 , 12]$, then the measure of the angle of friction is ....°

(a) 15 (b) 30 (c) 60 (d) 45

20 **In the opposite figure :**



A flag pole of height 12 metre is pulled by a force $\vec{F}$ of magnitude 13 newton acts in the direction of $\overrightarrow{AB}$, then the moment vector of the force $\vec{F}$ about the origin point = ...

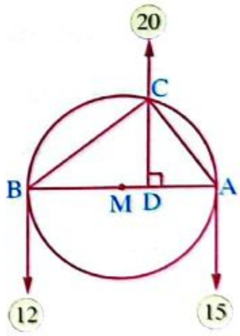
(a) $48\hat{i} + 36\hat{j}$

(b) $48\hat{i} - 36\hat{j}$

(c) $-48\hat{i} - 36\hat{j}$

(d) $-48\hat{i} + 36\hat{j}$

21 **In the opposite figure :**

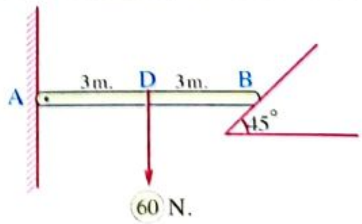


The coplanar parallel forces 20 , 15 , 12 newton act at the points C , A , B respectively in directions perpendicular to the diameter $\overline{AB}$ in the circle M , if AC = 6 cm. , CB = 8 cm. , then the sum of the algebraic measure of the moments of these forces about the center of the circle (M) equals .... newton.cm.

(a) – 13 (b) 43

(c) 13 (d) – 43

22 **In the opposite figure :**

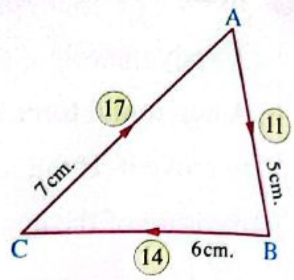


$\overline{AB}$ is a uniform rod of length 6 m. and of weight 60 newton its end A is attached to a fixed hinge at a vertical wall and its end B rests against a smooth plane inclined to the horizontal by an angle of measure 45° , if the rod equilibrated then the magnitude of the reaction at the hinge (A) = ... newton.

(a) $15\sqrt{2}$ (b) $30\sqrt{2}$ (c) 30 (d) 15

23 **In the opposite figure :**

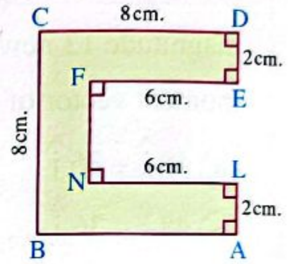
ABC is a triangle in which AB = 5 cm. , BC = 6 cm. , AC = 7 cm. , the shown forces in the figure measured in newton. If a force of magnitude F newton is added to each force to make the system equivalent to a couple , then the algebraic measure of the moment couple = ... newton.



(a) $-36\sqrt{6}$ (b) $36\sqrt{6}$ (c) 72 (d) -72

24 **In the opposite figure :**

A lamina of uniform thickness and density , AB = BC = CD = 8 cm. , LN = EF = 6 cm. , DE = AL = 2 cm. , then distance between the centre of gravity of the lamina and each of $\overleftrightarrow{BC}$, $\overleftrightarrow{BA}$ respectively is ....

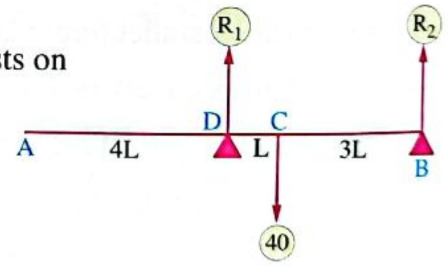


(a) 4.3 cm. , 3 cm. (b) 4 cm. , 3 cm.

(c) 3.4 cm. , 4 cm. (d) 3 cm. , 4 cm.

25 **In the opposite figure :**

$\overline{AB}$ is a non-uniform rod of weight 40 kg.wt. acts at C rests on two supports at B and D. If the rod equilibrated horizontally , then $R_1 - R_2$ = ... kg.wt.

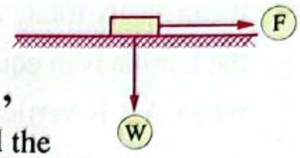


(a) 20 (b) 10

(c) 25 (d) 30

Answer the following questions :

1 **In the opposite figure :**

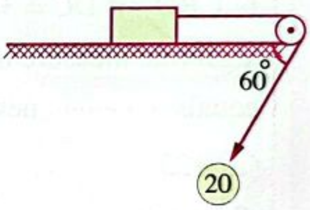


A body of weight (W) newton is placed on a rough horizontal plane , where the sine of the angle of limiting friction between the body and the plane = $\frac{4}{5}$, a horizontal force $\vec{F}$ acts on the body to make it about to move , if the magnitude of the friction force (measured by newton) $\in]0 , 12]$, then the weight of the body = ... newton.

(a) 9 (b) 15 (c) 9.6 (d) 16

---

2 **In the opposite figure :**



A body of weight 80 newton is placed on a horizontal rough plane , the body is tied to the end of a light inelastic string passes over a small smooth pulley and the other end of the string is tensioned by a force of magnitude 20 newton inclined to the horizontal with angle of measure 60° downward , if the body is about to move , then the coefficient of static friction between the body and the plane = ...

(a) $\frac{1}{8}$ (b) $\frac{1}{4}$ (c) $\frac{\sqrt{3}}{8}$ (d) $\frac{1}{2}$

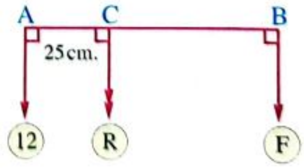
---

3 If the force $\vec{F} = 2\hat{i} - 3\hat{j}$ and the equation of its line of action is $3x + 2y = 0$, then the moment of the force $\vec{F}$ about the point A (1 , 2) equals .... $\hat{k}$

(a) -7 (b) 7 (c) -1 (d) 1

---

4 **In the opposite figure :**



The two forces F , 12 newton are parallel and the magnitude of their resultant is R , if AB = 75 cm. , AC = 25 cm. , then F and R respectively are .... , ... newton.

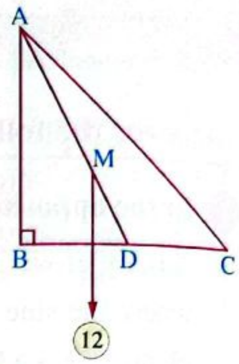
(a) 18 , 30 (b) 4 , 16 (c) 16 , 28 (d) 6 , 18

---

5 If a system of forces acting on the plane of square ABCD form a couple the norm of its moment equals 40 newton.cm. , then $\|\vec{M}_A\| + \vec{M}_B\| + 3\|\vec{M}_C\| - \|\vec{M}_D\|$ = ... newton.cm.

(a) 240 (b) 80 (c) 120 (d) 160

6 In the opposite figure :

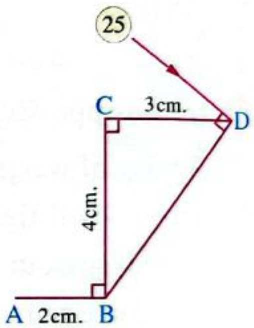


ABC is a lamina of uniform thickness and density in the form of right-angled triangle at B , BC = 30 cm. and its weight 12 newton , it can easily rotate about a small pin fixed near from the vertex A. If the lamina is in equilibrium under the action of a couple in its plane when $\overline{AB}$ is vertical , then the norm of the moment of the couple = ... newton.cm.

(a) 30 (b) 60 (c) 120 (d) 45

---

7 In the opposite figure :



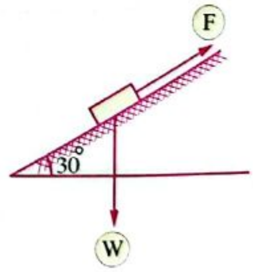
A force $\vec{F}$ of magnitude 25 newton acts at the point D such that $\vec{F} \perp \overline{BD}$, if DC = 3 cm. , BC = 4 cm. , AB = 2 cm. , then the algebraic measure of the moment of the force $\vec{F}$ about the point A equals .... newton.cm.

(a) 125 (b) 155

(c) – 155 (d) – 125

---

8 In the opposite figure :

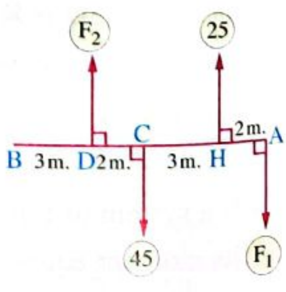


A body of weight (W) newton is placed on a rough plane inclined to the horizontal by an angle of measure 30° , a force of magnitude F newton in the direction of the line of the greatest slope upwards the plane acts on it to make the body about to move upwards when the magnitude of the resultant reaction between the body and the plane equals (W) newton , then F = ... newton.

(a) W (b) $\frac{\sqrt{3}}{2}$ W (c) $\frac{1}{2}$ W (d) $\sqrt{3}$ W

---

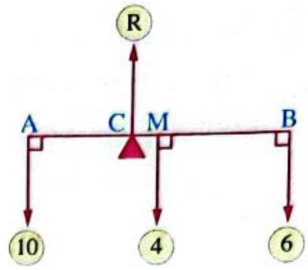
9 In the opposite figure :



$\overline{AB}$ is a uniform rod of length 10 m. and weight 45 kg.wt. a system of parallel forces act on the rod as shown in the opposite figure. If the magnitude of their resultant = 50 kg.wt. and acts vertically downward at the point M where M $\in \overline{AB}$ where AM = 0.7 m. , then $F_1 : F_2$ = ...

(a) 5 : 2 (b) 2 : 5 (c) 4 : 9 (d) 9 : 4

10 **In the opposite figure :**



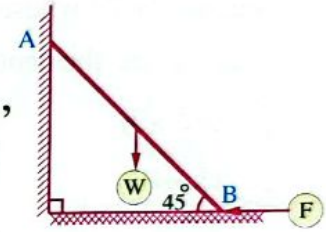
$\overline{AB}$ is a uniform rod of length 100 cm. and of weight 4 kg.wt. rests on a smooth support at the point C and a system of parallel forces act on it as shown in the figure (measured in kg.wt.) , if the rod equilibrated horizontally , then MC = ... cm.

(a) 30 (b) 40

(c) 50 (d) 10

---

11 **In the opposite figure :**

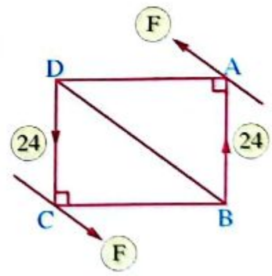


$\overline{AB}$ is a uniform rod of weight (W) rests with its ends A against a smooth vertical wall and its end B on a rough horizontal ground , the coefficient of static friction between them is $\frac{3}{4}$. If a horizontal force acted on the rod at the point B to make it about to move towards the wall when the rod inclined to the horizontal by an angle of measure 45° , then the magnitude of the horizontal force = ...

(a) $\frac{1}{4}$ w (b) $\frac{5}{4}$ w (c) $\frac{3}{4}$ w (d) $\frac{7}{4}$ w

---

12 **In the opposite figure :**

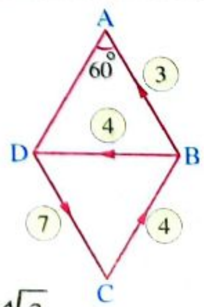


ABCD is a rectangle in which AB = 6 cm. , BC = 8 cm. , the two forces of magnitudes F , F newton act at the two points A and C and parallel to $\overleftrightarrow{BD}$ to form a couple (as the figure shown) , if another two forces of magnitudes 24 , 24 newton act along $\overrightarrow{BA}$ and $\overrightarrow{DC}$ to form a couple equivalent to the first couple , then F = ... newton.

(a) 14.4 (b) 20 (c) 25 (d) 19.2

---

13 **In the opposite figure :**



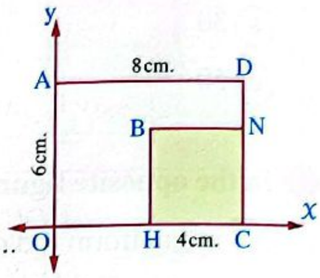
ABCD is a rhombus of side length 6 cm. , m (∠ A) = 60° , the forces of magnitudes 3 , 7 , 4 and 4 newton act along $\overrightarrow{BA}$, $\overrightarrow{DC}$, $\overrightarrow{CB}$, $\overrightarrow{BD}$ respectively , if the system is equivalent to a couple , then the norm of its moment = ... newton.cm.

(a) $10\sqrt{3}$ (b) $15\sqrt{3}$ (c) $25\sqrt{3}$ (d) $21\sqrt{3}$

14 Two masses 8 , (k) kg. are placed at the two points A and B respectively where AB = 40 cm. , if the centre of gravity of the system acts at the point C where $C \in \overline{AB}$ and AC = 24 cm. , then k = ... kg.

(a) 8 (b) 12 (c) 16 (d) 24

15 **In the opposite figure :**



AOCD is a fine lamina of a uniform thickness and density in the form of a rectangle in which AO = 6 cm. , OC = 8 cm. If the square CHBN whose side length 4 cm. is cut off as shown in the figure , then the center of gravity of the remaining part is ....

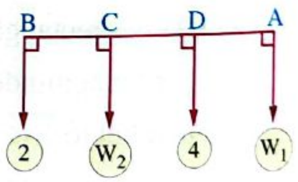
(a) (3.5 , 3) (b) (3 , 3)

(c) (3 , 4) (d) (3 , 3.5)

16 If the line of action of $\overrightarrow{F} = \hat{i} + 2\hat{j} + \hat{k}$ intersects z-axis at the point A and the component of the moment of the force $\overrightarrow{F}$ about y-axis equals 5 moment unit , then the point A is ....

(a) (0 , 0 , – 5) (b) (0 , 0 , 10) (c) (0 , 0 , 5) (d) (0 , 0 , – 10)

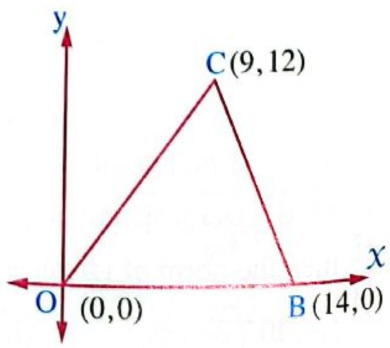
17 **In the opposite figure :**



$\overline{AB}$ is a light ruler of negligible weight and of length 300 cm. , forces of magnitudes W_1 , 4 , W_2 and 2 gm.wt. act in a direction perpendicular to $\overline{AB}$ where AD = DC = CB. If the magnitude of their resultant = 10 gm.wt. and acts at the point M where AM = 130 cm. , then $W_1 - W_2$ = ... gm.wt.

(a) 1 (b) 2 (c) 3.5 (d) 4

18 **In the opposite figure :**

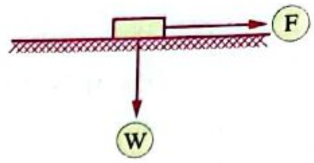


A thin wire of uniform thickness and density in the form of a triangle OBC , where B (14 , 0) and C (9 , 12) , then the coordinates of the center of gravity of the wire is ....

(a) (7.5 , 4) (b) (4 , 7)

(c) (4.5 , 7) (d) (7 , 4.5)

19 **In the opposite figure :**

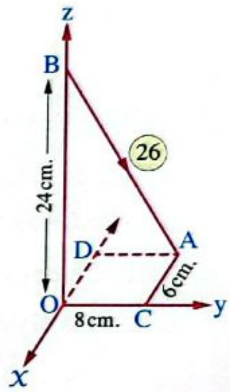


A horizontal force $\vec{F}$ (where F measured by newton) acts on a body of weight (W) newton placed on a rough horizontal plane , if the measure of the angle between the weight $\overrightarrow{W}$ and the resultant reaction $\vec{R}$ is θ , then the resultant reaction R = ... newton.

(a) $-W \sin \theta$ (b) $-W \sec \theta$ (c) $W \cos \theta$ (d) $W \csc \theta$

---

20 **In the opposite figure :**



B $\in$ z-axis , BO = 24 cm. , D $\in$ x-axis , C $\in$ y-axis , ACOD is a rectangle where AC = 6 cm. , CO = 8 cm.

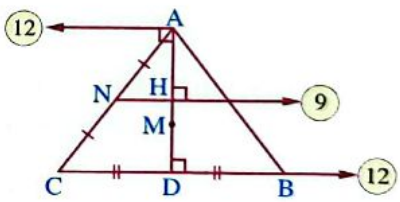
A force $\vec{F}$ of magnitude 26 newton acts in the direction $\overrightarrow{BA}$, then $\overrightarrow{M_O}$ = ...

(a) $-192\hat{i} + 144\hat{j}$ (b) $192\hat{i} - 144\hat{j}$

(c) $-192\hat{i} - 144\hat{j}$ (d) $144\hat{i} - 192\hat{j}$

---

21 **In the opposite figure :**

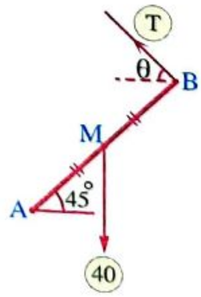


ABC is a triangle in which AB = AC = 15 cm. , BC = 18 cm. , the coplanar parallel forces 12 , 9 , 12 newton act at the points A , N , C respectively and perpendicular to $\overline{AD}$, if M is the point of intersection of the medians of triangle ABC , then the sum of the algebraic measures of moments of these forces about the point M = ... newton.cm.

(a) -126 (b) 162 (c) -162 (d) 126

---

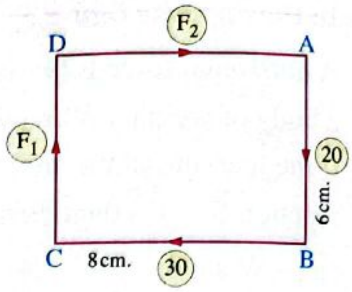
22 **In the opposite figure :**



$\overline{AB}$ is a uniform rod of weight 40 kg.wt. its end A is attached to a fixed hinge and its end B is pulled by a light inelastic string inclined to the horizontal by an acute angle of measure θ , the rod equilibrated when it makes an angle of measure 45° with the horizontal. If the magnitude of the reaction of the hinge in equilibrium position = $10\sqrt{10}$ kg.wt. , then the reaction of the hinge inclined to the horizontal by angle of tangent = ...

(a) $\frac{1}{3}$ (b) 3 (c) $\frac{1}{2}$ (d) 1

23 In the opposite figure :

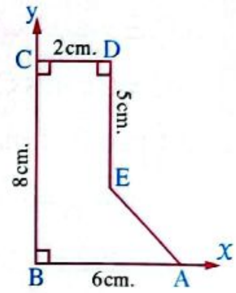


ABCD is a rectangle in which AB = 6 cm. , BC = 8 cm. the forces (measured in newton) act as shown in the figure , if a force of magnitude F newton is added to each force where F ≠ zero , the forces became completely represented by the sides of the rectangle , then the system is equivalent to a couple the algebraic measure of its moment = ... newton.cm.

(a) 480 (b) – 480 (c) 300 (d) – 300

---

24 In the opposite figure :



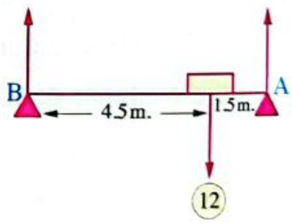
ABCDE is a fine lamina of a uniform thickness and density , where AB = 6 cm. , BC = 8 cm. , CD = 2 cm. and DE = 5 cm. , then the center of gravity of the lamina with respect to $\overrightarrow{BC}$, $\overrightarrow{BA}$ respectively is ....

(a) $\left(\frac{18}{11}, \frac{35}{11}\right)$ (b) $\left(\frac{73}{22}, \frac{20}{11}\right)$

(c) $\left(\frac{48}{11}, \frac{35}{11}\right)$ (d) $\left(\frac{20}{11}, \frac{73}{22}\right)$

---

25 In the opposite figure :



$\overline{AB}$ is a uniform wooden board of length 6 m. and of mass 10 kg. per each meter of its length , it rests horizontally on two smooth supports at A , B. If a box of weight 12 kg.wt. is placed on it as shown in the figure , then the magnitude of the pressure on the support at B = ... kg.wt.

(a) 33 (b) 36 (c) 6 (d) 11

Al-Azhar Exams

(2019 : 2021 first and second sessions)

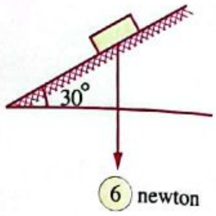
in

Statics

Answer the following question :

1 Choose the correct answer from the given ones :

(1) In the opposite figure :



If the body is about to move downwards

, then the limiting friction static force = ... newton.

(a) 3 (b) $\sqrt{3}$ (c) $3\sqrt{3}$ (d) 9

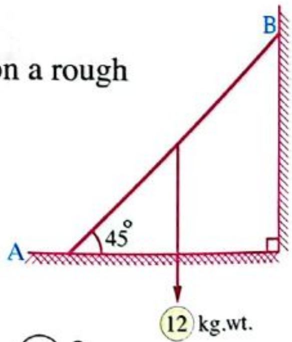
(2) If the force $\overrightarrow{F} = \hat{i} + \hat{j}$ acts at D (1 , 4) where D is the midpoint of $\overline{AB}$, A (3 , – 1) , then $\overrightarrow{M_B}$ = ... $\hat{k}$

(a) – 7 (b) 7 (c) 3 (d) – 14

(3) If the magnitudes of two like parallel forces are $\frac{A}{B}$, $\frac{B}{A}$ newton and their resultant equals 2 newton , then ....

(a) A = 2 B (b) B = 2 A (c) $A = B^2$ (d) A = B

(4) In the opposite figure :

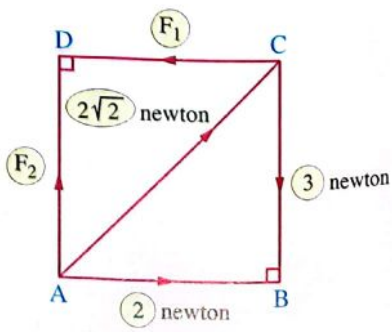


$\overline{AB}$ is a uniform ladder of weight 12 kg.wt. rests with its and A on a rough horizontal ground and with its end B on a smooth vertical wall.

If the ladder be in equilibrium in position inclined the horizontal with an angle of measure 45° , then the magnitude of the static friction force = ... kg.wt.

(a) 12 (b) 6 (c) $\frac{1}{2}$ (d) 3

(5) In the opposite figure :



ABCD is a square , the shown forces are measured in newton. If the system of forces are equivalent to a couple , then $F_1 - F_2$ = ... newton.

(a) 2 (b) 3

(c) 1 (d) – 1

(6) In the opposite figure :

Represents a thin wire of uniform thickness and density , where AB = 4 cm. , BC = 12 cm. , m (∠ B) = 90° If the wire is freely suspended from point B , then the tangent of the angle of inclination of $\overline{BC}$ to the vertical = ...

(a) 3 (b) $\frac{1}{3}$ (c) $\frac{1}{2}$ (d) $\frac{1}{9}$

Answer three questions only of the following :

2 **[a]** A body of weight 16 kg.wt. is placed on a horizontal rough plane , then the plane incline gradually until the body becomes about to move downwards the plane when the measure of the angle of inclination to the horizontal is 30°

Find the coefficient friction between the body and the plane. If the body is tied by a string and the string is attached in direction makes an angle of measure 30° with the plane until the body becomes about to move upwards the plane.

Find the magnitude of the :

(1) Tension force. **(2)** Normal reaction.

[b] A fine lamina of uniform thickness and density in the form of a trapezium ABCD in which m (∠ A) = m (∠ D) = 90° , CD = 40 cm. , AD = 60 cm. , and AB = 120 cm. Determine the distance between the center of gravity of the lamina and both of $\overline{AD}$, $\overline{AB}$ If the lamina is freely suspended from the point A , find the tangent of the angle of inclination of $\overline{AB}$ to the vertical in the equilibrium position.

---

3 **[a]** If the force $\vec{F} = \hat{i} - b\hat{j} + \hat{k}$ acts at point A (– 1 , 2 , 3) and the component of the moment of $\vec{F}$ about X-axis = – 4 moment units. Find the value of B , hence find the length of the perpendicular segment drawn from the origin point to the line of action of the force.

[b] ABCD is a square of side length 10 cm. , $E \in \overrightarrow{CB}$, $F \in \overrightarrow{CD}$ such that CE = CF = 30 cm. Forces of magnitudes 40 , 10 , 20 , 30 and $20\sqrt{2}$ kg. w.t. act at $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DA}$ and $\overrightarrow{EF}$ respectively. Prove that the system is equivalent to a couple and find the magnitude of its moment.

4 **[a]** $\overline{AB}$ is a non uniform rod of length 1 m. is rests in a horizontal position on two supports at C , D where AC = 20 cm. , BD = 10 cm. If the heaviest weight can be suspended at point A or point B without disturbing the rod is 5 , 4 kg.wt. respectively , find the weight of the rod and the distance from its point of action to A.

[b] Two forces $\overrightarrow{F_1} = \hat{i} + \hat{j}$, $\overrightarrow{F_2} = m\,\hat{i} - 2\,\hat{j}$ act at the two points A (2 , 0) , B (0 , 2) respectively. Determine the value of the constant m such that the sum of the two moments of those two forces about the point C (1 , 3) vanishes.

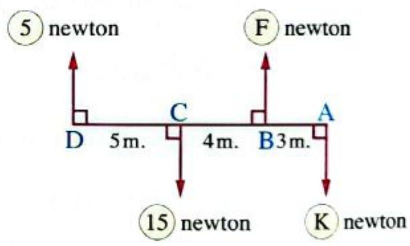
---

5 **[a]** A uniform rod of weight (w) rests on a rough vertical wall with an end and on a rough horizontal ground with the other end and coefficient of friction between the rod and the wall is equal to $\frac{1}{4}$ and the coefficient of friction between the rod and ground is equal to $\frac{1}{3}$. If the rod is in equilibrium at a vertical plane perpendicular to the wall , find the tangent of the angle of inclination of the rod to the vertical as the rod is about to slip.

[b] The opposite figure :

Shows the effect of a system of forces on the rod $\overline{AD}$, if these forces form a couple the algebraic measure of the magnitude of its moment is equal to – 75 newton.m.

Find the value for each of F and K



Answer the following question :

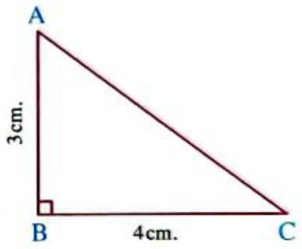
1 Choose the correct answer from the given ones :

(1) If a , b , c are three coplanar and non collinear points , a system of forces lies in the same plane of these points and form a couple such that $2\ M_a + 3\ M_b + 5\ M_c = 240$ newton.cm. , then $6\ M_a - 2\ M_c = \dots\dots$ newton.cm.

(a) 24 (b) 48 (c) 96 (d) 192

(2) In the opposite figure :

A thin wire of uniform thickness and density in the form of a right angled triangle ABC right at B , AB = 3 cm. , BC = 4 cm. , then distance from the center of gravity of the wire from each of $\overline{BA}$, $\overline{BC}$ is ....



(a) 1.5 cm. , 1 cm.

(b) 2 cm. , 1.5 cm.

(c) $\frac{5}{2}$ cm. , $\frac{9}{4}$ cm.

(d) $\frac{12}{7}$ cm. , $\frac{11}{14}$ cm.

(3) A body of weight 6 kg. wt. is placed on a rough horizontal plane , the coefficient of friction between it and the body is $\frac{1}{2}$. A force of magnitude F kg.wt. acts on it and its line of action inclined to the horizontal plane by an angle of measure 45° if the body is about to move , then F = ... kg.wt.

(a) $3\sqrt{2}$ (b) $\frac{3\sqrt{2}}{2}$ (c) $\frac{3}{\sqrt{2}}$ (d) $2\sqrt{2}$

(4) If the moment of a force $\vec{F}$ about point A is equal to its moment about point B , then ....

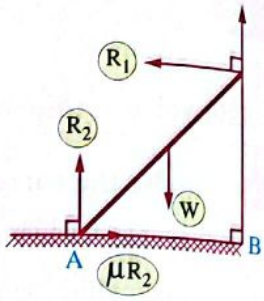
(a) $\vec{F} \perp \overline{AB}$ (b) $\vec{F} \parallel \overleftrightarrow{AB}$

(c) $\vec{F}$ bisects $\overleftrightarrow{AB}$ (d) $\overleftrightarrow{AB}$ action line and $\vec{F}$ are skew.

(5) If $\vec{F_1} \parallel \vec{F_2}$ and in opposite direction , then $\vec{R} = \dots\dots$

(a) $\vec{F_1} - \vec{F_2}$ (b) $\vec{F_2} - \vec{F_1}$ (c) $\vec{F_1} + \vec{F_2}$ (d) $\vec{F_1} \times \vec{F_2}$

(6) In the opposite figure :



$R_1 - R_2 = \dots\dots\dots\dots$

(a) $w(\mu - 1)$

(b) $1 - \mu$

(c) $w(1 - \mu)$

(d) $\mu - 1$

Answer three questions only of the following :

2 **[a]** $\overline{AB}$ is a rod of length 90 cm. and weight 50 newtons. acting at its midpoint rests horizontally on two supports one of them at end A and the other at the point C distant 30 cm. from B carries a 20 newton weight at a point distant 15 cm. from B Find the value of pressure exerted on each support and find the magnitude of the weight which should be suspended from end B such that the rod is about to rotate. What is the value of the pressure exerted on C hence.

[b] The forces $\overrightarrow{F_1} = 5\hat{i} + 2\hat{j}$, $\overrightarrow{F_2} = \hat{i} - 4\hat{j}$, $\overrightarrow{F_3} = -6\hat{i} + 2\hat{j}$ act at the points A (2 , 3) , B (– 2 , 3) , C (0 , 0) respectively. Prove that the system of forces is equivalent to a couple and find the magnitude of its moment.

---

3 **[a]** A uniform rod $\overline{AB}$ of length 60 cm. and weight 8 newton is hinged at its end A to a hinge fixed on a vertical wall. A weight of 6 newtons suspended at a point in the rod distant 40 cm. from the end A. The rod is being kept in equilibrium in horizontal position by a light string attached at one of its two ends with the end B of the rod while the other end of the string is fixed at a point on the wall distant 80 cm. vertically upwards from A.

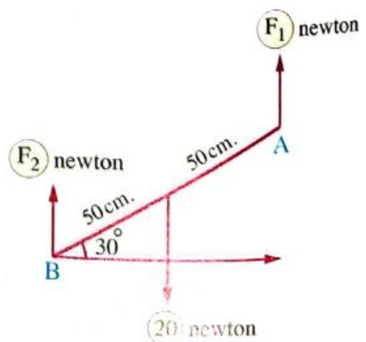
Find : (1) The tension in the string.

(2) The reaction of the hinge and its direction.

[b] The opposite figure :

Shows a uniform rod $\overline{AB}$ in a position of equilibrium under the action of the forces shown in the figure.

Find : F_1 and F_2



4 [a] A body of weight (w) is placed on a rough plane inclined to the horizontal by an angle of measure (θ) , it is found that the force which parallel to the line of greatest slope of the plane and makes the body is about to move upwards the plane equals ($2\ w \sin\theta$)

Prove that : (1) The measure of the angle of friction = θ

(2) The magnitude of the resultant reaction = w

[b] A fine lamina of uniform thickness and density in the form of square ABCD of side length 48 cm. and M is the intersection point of its diagonals. The triangle CMD is cut off , then stuck on the triangle CMB such that $\overline{MD}$ is coincident to $\overline{MB}$. Find the distance between the center of gravity of the lamina and both $\overline{BA}$ and $\overline{BC}$

---

5 [a] If the moment of the force $\vec{F} = 2\hat{i} + 3\hat{j} - \hat{k}$ about the origin point O is equal to $\vec{M}_o = 5\hat{i} - 3\hat{j} + \hat{k}$ and if this force passes through a point whose y-coordinate is equal to 4 Find the coordinates x and z for the point , hence find the length of the perpendicular segment drawn from the origin point to the line of action of the force.

[b] ABCD is a rectangle in which AB = 60 cm. , BC = 160 cm. , X and Y are midpoints of $\overline{BC}$ and $\overline{AD}$ respectively. The forces of magnitudes 200 , 200 , 400 , 400 , F and F newton act in the directions $\overrightarrow{AB}$, $\overrightarrow{CD}$, $\overrightarrow{CB}$, $\overrightarrow{AD}$, $\overrightarrow{XA}$ and $\overrightarrow{YC}$ respectively. If the algebraic measure of the moment of the resultant couple is equal to 6400 newton.cm. in the direction of ADCB , find the value of F.

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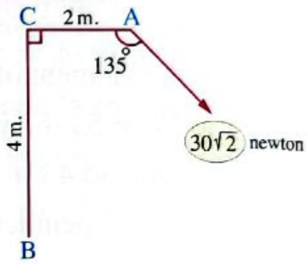
Answer the following question :

1 Choose the correct answer from the given ones :

(1) If the limiting static force is 60 newton and the resultant reaction force 100 newton , then the force of the normal reaction = ... newton.

(a) 60 (b) 100 (c) 80 (d) 200

(2) In the opposite figure :



The algebraic measure of the moment of the force $30\sqrt{2}$ newton about the point B = ... newton. meter.

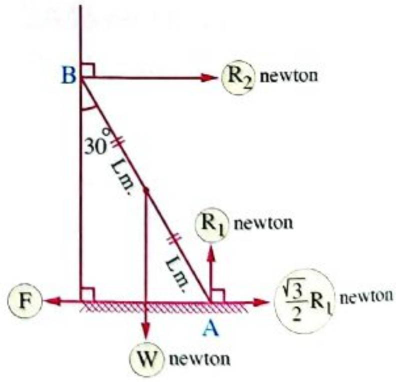
(a) 60 (b) – 180

(c) 120 (d) 240

(3) If $\overrightarrow{F_1} \parallel \overrightarrow{F_2}$, their resultant $\overrightarrow{R} = -2\,\overrightarrow{F_1}$ and $\overrightarrow{F_2} = -9\,\hat{i} + 12\,\hat{j}$, then $\overrightarrow{F_1} =$ ....

(a) $-15\,\hat{i} + 20\,\hat{j}$ (b) $-3\,\hat{i} + 4\,\hat{j}$ (c) $3\,\hat{i} - 4\,\hat{j}$ (d) $15\,\hat{i} - 20\,\hat{j}$

(4) The opposite figure represents a rod $\overline{AB}$ in equilibrium position , then F = ... newton.



(a) $\frac{2\sqrt{3}}{3}$ w

(b) $\frac{\sqrt{3}}{3}$ w

(c) $2\sqrt{3}$ w

(d) $\frac{3\sqrt{2}}{2}$ w

(5) If the two forces $2\,\overrightarrow{F_1}$, $3\,\overrightarrow{F_2}$ form a couple and $\overrightarrow{F_2} = 4\,\hat{i} - 2\,\hat{j}$, then $\overrightarrow{F_1} =$ ....

(a) $6\,\hat{i} - \hat{j}$ (b) $6\,\hat{i} - 3\,\hat{j}$ (c) $12\,\hat{i} - 6\,\hat{j}$ (d) $-6\,\hat{i} + 3\,\hat{j}$

(6) If $\overrightarrow{F} = 15\,\hat{i} - 25\,\hat{j} + 40\,\hat{k}$ acts at point A (– 3 , – 3 , 2) , then the component of the moment of $\overrightarrow{F}$ about y-axis = ...

(a) 75 (b) 300 (c) 150 (d) 450

Answer three questions only of the following :

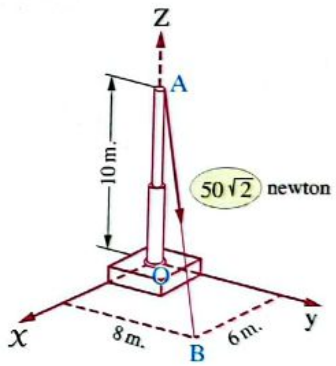
2 **[a]** A body of weight 2 kg.wt is placed on a plane inclined to the horizontal by an angle of measure 30° and the static friction coefficient between the plane and the body is $\frac{\sqrt{3}}{2}$ A force of magnitude $\frac{5}{2}$ kg.wt acts on the body and in the line of the greatest slope upwards. If the body is in equilibrium. determine the friction force and show whether the body is about to move or not ?

[b] A , B , C , D and E are points on one straight line such that AB = 4 cm. , BC = 6 cm. , CD = 8 cm. and DE = 10 cm. Five forces of magnitudes 60 , 30 , 50 , 80 and 40 kg.wt act at the points A , C , D , B and E respectively and in perpendicular direction to $\overleftrightarrow{AE}$ such that the first three forces are in the same direction and the other two forces are in opposite direction. Find the magnitude and the direction of the resultant and then find the distance between the point of action of the resultant and the point A.

---

3 **[a] In the opposite figure :**

A force of magnitude $50\sqrt{2}$ newton act at point A. Find the moment of the force about point O.



[b] ABCD is a rectangle in which AB = 30 cm. , BC = 40 cm. , forces of magnitudes 1 , 2 , 4 , 6 and 5 kg.wt act at $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DA}$ and $\overrightarrow{AC}$ respectively.

Prove that : The system is equivalent to a couple and find the magnitude of its moment.

---

4 **[a]** $\overline{AB}$ is a uniform rod of length 60 cm. and weight 8 newton is hinged at its end A to a hinge fixed at vertical wall. A weight of 6 newton is suspended at a point in the rod distant 40 cm. from the end A. The rod is being kept in horizontal position by a light string attached at one of its two ends with the end B of the rod while the other end of the string is fixed at a point on the wall distant 80 cm. vertically upwards from A. Find the tension in the string and the reaction of the hinge.

[b] If $\overrightarrow{F} = \ell\,\hat{i} + m\,\hat{j}$ acts at point A (3 , – 2) and if the moment of the force $\overrightarrow{F}$ about the origin point is equal to $\overrightarrow{O}$ and about the point B (– 1 , 2) is equal to $-8\,\hat{k}$, find the value of each of L and M.

5 **[a]** Based light ruler $\overline{AB}$ measured by cm. rests horizontally on two supports at C , D where $C \in \overline{AD}$, 2 AC = 2 BD = CD , and suspended weight of magnitude (W) newton from the point M on the ruler. Its found that the ruler is on the verge of a coup if a weight of magnitude 10 newton is suspended from A or a weight of 6 newton is suspended from B.

(1) Find the magnitude of (W) **(2)** Prove that : $\frac{AM}{MB} = \frac{9}{7}$

[b] ABCD is a fine uniform lamina in the form of a square whose side length is 60 cm. and of weight 200 gm.wt acts at the point at which the diagonals meet. The lamina is suspended by a pin from a small hole near the vertex A such that its plane is vertical and a couple acts on its plane of magnitude $3000\sqrt{2}$ gm.wt.cm. Find the measure of the angle of inclination of $\overline{AC}$ to the vertical in the position of equilibrium.

Answer the following question :

1 Choose the correct answer from the given ones :

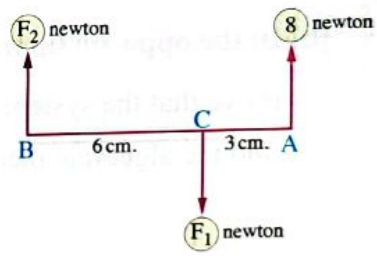
(1) If the two forces $\overrightarrow{F_1} = (2 , b)$ and $\overrightarrow{F_2} = (a , -5)$ form a couple and act at the two points C $(-1 , 3)$ and D $(2 , 2)$ respectively , then the moment of the couple = ... $\hat{e}$.

(a) -13 (b) 17 (c) 13 (d) -17

(2) Two like forces of magnitudes F , 2 F act at the two point A and B respectively where AB = 39 cm. , then the resultant acts at point C where AC = ... cm.

(a) 13 (b) 15 (c) 26 (d) 18

(3) In the opposite figure :



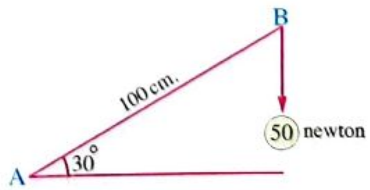
If the system is in equilibrium , then $F_1 + F_2$ = ... newton.

(a) 16 (b) 12 (c) 8 (d) 4

(4) If μ_s , μ_k are coefficients of static and kinetic friction respectively for two connected bodies , then ....

(a) $\mu_s = \mu_k$ (b) $\mu_s > \mu_k$ (c) $\mu_s < \mu_k$ (d) no relation between them.

(5) In the opposite figure :

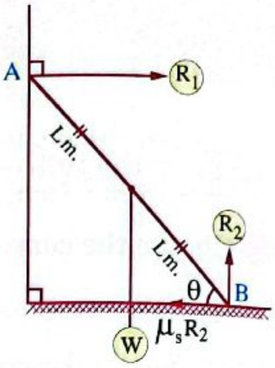


$\overline{AB}$ is a rod fixed by a hinge at A.

If a vertical force of magnitude 50 newton acts on the end B downwards , then the magnitude of the moment of the force about A is equal .... newton meter.

(a) 25 (b) $25\sqrt{3}$ (c) 2500 (d) $2500\sqrt{3}$

(6) In the opposite figure :



$\overline{AB}$ is a uniform rod about to move , then the coefficient of static friction μ_s = ...

ⓐ $\frac{1}{2}\tan\theta$ ⓑ $\frac{1}{2}\cot\theta$

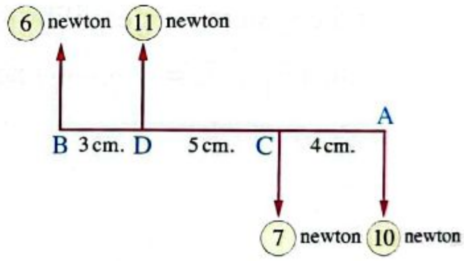
ⓒ $\frac{1}{4}\tan\theta$ ⓓ $\cot\theta$

Answer three questions only of the following :

2 **[a]** $\overline{AB}$ is a uniform ladder of length 10 meters and weight 20 kg.wt rests on a rough horizontal ground with its end A. The coefficient of friction between the ground and the ladder is $\frac{1}{4}$. The ladder also rests on a smooth vertical wall with its end B. Prove that the ladder cannot be in equilibrium when the end B is distant 8 meters from the ground surface.

[b] In the opposite figure :

Prove that the system is equivalent to a couple and find the algebraic measure of its moment.



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3 **[a]** A body of weight 10 kg.wt is placed on an inclined plane makes an angle of measure 30° with the horizontal , if the body is about to slide , find the force which acts on the line of the greatest slope to make the body about to move up the plane.

[b] ABCD is a square of side length is 6 cm. and E $\in \overline{BC}$ where BE = 1 cm. , forces of magnitudes 1 , 2 , 3 , 4 and F newtons act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DA}$ and $\overrightarrow{AC}$ respectively. If the line of action of the resultant passes through point E , find the value of F.

---

4 **[a]** A body of weight 12 kg.wt is placed on a horizontal rough plane , two forces of magnitudes 4 , 4 kg.wt and include an angle of measure 60° where the two horizontal forces are on the same horizontal plane. If the body is about to move.

Find : (1) The coefficient of static friction between the body and the plane.

(2) The measure of the angle of friction.

[b] ABCD is a rectangle in which AB = 30 cm. , BC = 40 cm. Forces of magnitudes 15 , 30 , 15 , and 30 gm.wt act at $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$ and $\overrightarrow{DA}$ respectively. Prove that the system is equivalent to a couple and find its moment , then find the two forces acting at A , C perpendicular to $\overline{AC}$ such that the system is in equilibrium.

---

5 **[a]** If $\hat{i}$, $\hat{j}$, $\hat{k}$ a right system of the unit vectors , the force $\vec{F} = 3\hat{i} + m\hat{j} + 4\hat{k}$ acts at point A (1 , 0 , – 1) and the moment of the force $\vec{F}$ about point B (2 , – 1 , 3) is equal to $12\hat{i} - 8\hat{j} - 5\hat{k}$. Find the value of m.

[b] $\overline{AB}$ is a uniform wooden board of weight 10 kg.wt. and length 4 meters. If it rests horizontally on two supports one of them at A and the other at point distant 1 meter from B , then show at which distance from A , 50 kg.wt. Child stand on the board in order for the two reactions on the supports get equal.

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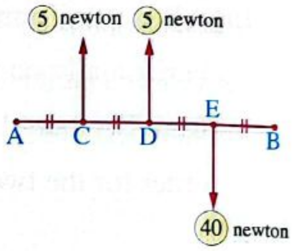
Answer the following question :

1 **Choose the correct answer from the given ones :**

(1) If θ is the measure of the angle included between the limiting static friction force and the resultant reaction and $2\,\theta$ is the measure of the angle included between the normal reaction and the resultant reaction , then the coefficient of friction = ...

(a) 4 (b) $\sqrt{3}$ (c) $\frac{\sqrt{3}}{3}$ (d) $\sec\theta$

(2) In the opposite figure :

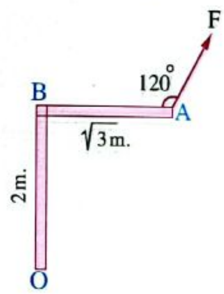


The point of action of the resultant $\in$ ....

(a) $\overline{AC}$ (b) $\overline{CD}$

(c) $\overline{DE}$ (d) $\overline{EB}$

(3) In the opposite figure :



The magnitude of the moment of the force F about the point O = ... newton.m.

(a) $\frac{1}{2}$ F (b) F

(c) $\frac{5}{2}$ F (d) $\sqrt{3}$ F

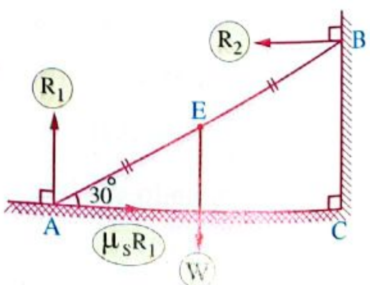
(4) Three masses 1 kg. , 2 kg. , m kg. are placed at the points A (5 , 2) , B (1 , 5) , C (1 , – 2) respectively. If the center of gravity of this system is (2 , y) , then m + y = ...

(a) 3.5 (b) $\frac{1}{2}$ (c) – 1.5 (d) $-\frac{1}{2}$

(5) If a system of forces form a couple , the points A , B and C lies in the same plane of forces and are non-collinear where $2\,M_A + M_B = 12$ newton.cm. , then M_C = ... newton.cm.

(a) 4 (b) 8 (c) 12 (d) 16

(6) In the opposite figure :



If μ_s is the coefficient of static friction between the ground and the rod $\overline{AB}$, then the measure of the angle of friction = ... «$\overline{AB}$ is about to move».

(a) 30° (b) 60°

(c) 45° (d) 40.9°

Answer three questions only of the following :

2 **[a]** A body of weight 2 kg.wt. is placed on a horizontal rough plane , then the plane inclined step by step so that the body become about to move downwards the plane when the measure of the angle of inclination to the horizontal is 30°. Find the static coefficient friction between the body and the plane. If the body is tied by a string and the string is tensioned in a direction makes an angle of measure 60° to the horizontal upward until the body become about to move upwards the plane , **find :**

(1) The magnitude of the tension force.

(2) The magnitude of the static friction force.

[b] The forces $\overrightarrow{F_1} = 2\hat{i} - 4\hat{j}$, $\overrightarrow{F_2} = \hat{i} - 3\hat{j}$, $\overrightarrow{F_3} = -3\hat{i} + 7\hat{j}$ act at points A (– 1 , 1) , B (– 2 , 3) , C (0 , 1) respectively. Prove that the system of the forces is equivalent to a couple and find the magnitude of its moment.

---

3 **[a]** If the force $\vec{F} = a\hat{i} + 4\hat{j} - \hat{k}$ acts at point A whose position vector with respect to the origin point is $\vec{r} = (1 , 2 , 2)$ and the component of the moment of the force $\vec{F}$ about y-axis is equal to 7 moment unit. **Find :**

(1) The value of a

(2) The length of the perpendicular drawn from the origin point O on the line of action of $\vec{F}$

[b] A fine lamina of a uniform density in the form of square ABCD of side length 36 cm. , its two diagonals intersect at M , $\overline{DM}$ is bisected at point E and the triangle EAD is separated , determine the center of gravity of the remaining part of the lamina. If the lamina is freely suspended from point A until it gets in equilibrium in a vertical plane , find the tangent of inclination angle of $\overrightarrow{AB}$ to the vertical.

---

4 **[a]** $\overline{AB}$ is a non uniform rod of length 80 cm. and weight 20 kg.wt. rests horizontally on two supports at C and D such that AC = BD = 10 cm. A weight of magnitude 40 kg.wt. is suspended from A and the rod becomes to rotate about C.

Find :

(1) The distance from the point of action of the rod weight to A

(2) The maximum weight that can be suspended from B and lifting the suspended from A without getting unbalanced.

[b] A non uniform rod $\overline{AB}$ of length 140 cm. rests on horizontal ground with its end B and on a vertical wall with its end A. If the two coefficients of friction between the rod and both of the ground and the wall are equal to $\frac{1}{2}$ and $\frac{1}{3}$ respectively , if the rod is about to slip when the measure of its angle of inclination is 45° to the horizontal , find the distance between the point of action of the rod weight center and the end B. (The rod lies in a vertical plane perpendicular to the line of conjunction between the wall and the ground)

---

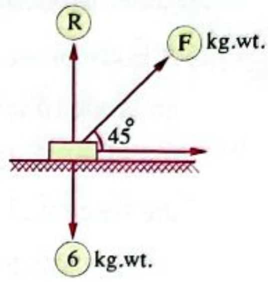
5 **[a]** ABCD is an isosceles trapezium in which $\overline{AD} \parallel \overline{BC}$, AD = 9 cm. , AB = DC = 15 cm. and BC = 33 cm. The forces of magnitudes 45 , 99 , 45 and 27 newton act in the directions of $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DA}$ respectively. Prove that the system is equivalent to a couple and find the magnitude of its moment.

[b] A fine wire of a uniform thickness and density is bent in the form of a right angled triangle ABC in which AB = 3 cm. and BC = 4 cm. Find the distance between the center of gravity of the wire and both of $\overline{BA}$ and $\overline{BC}$ and then find the distance between the center of gravity and point B

Answer the following question :

1 **Choose the correct answer from the given ones :**

(1) In the opposite figure :



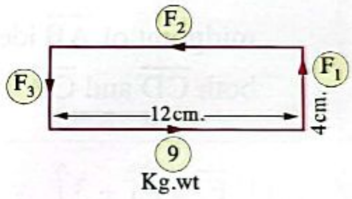
If the body is about to move , coefficient of static friction = $\frac{1}{2}$

, then F = ... kg.wt.

(a) $2\sqrt{2}$ (b) $3\sqrt{2}$

(c) $\frac{3}{\sqrt{2}}$ (d) $\sqrt{2}$

(2) In the opposite figure :



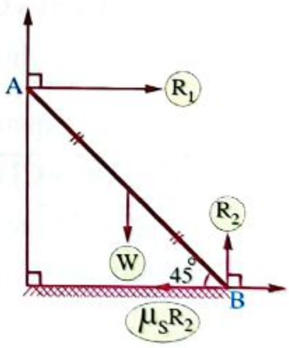
If the two couples are equivalent

, then $F_1 + F_2 + F_3$ = ... kg.wt.

(a) 9 (b) 15

(c) 4 (d) 30

(3) In the opposite figure :



If the rod $\overline{AB}$ is about to move

, then μ_s = ...

(a) $\frac{1}{2}$ (b) $\frac{1}{4}$

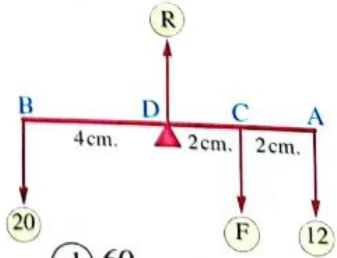
(c) $\frac{1}{8}$ (d) $\frac{1}{3}$

(4) If the force $\vec{F} = m\,\hat{i} + 7\,\hat{j} + n\,\hat{k}$ acts at the point A (4 , – 3 , – 5) and the vector of the moment of this force about the origin point equals $2\,\hat{i} + 6\,\hat{j} + 2\,h\,\hat{k}$

, then m + n + h = ...

(a) 2 (b) – 2 (c) – 20 (d) zero

(5) In the opposite figure :



$\overline{AB}$ is a uniform rod of weight 12 newton and in equilibrium position , then the pressure on the support = ... newton.

(a) 12 (b) 32 (c) 48 (d) 60

(6) The centre of gravity of a uniform fine lamina in the form of an equilateral triangle of side length 12 cm. is distant .... form one of the vertices of the triangle.

(a) $2\sqrt{3}$ (b) $4\sqrt{3}$ (c) 6 (d) $6\sqrt{3}$

Answer three questions only of the following :

2 **[a]** A body of weight 6 newton is placed in a rough plane , inclined to the horizontal by an angle of cosine $\frac{4}{5}$ and the measure of the angle of friction between the body and the plane is 45°. Show that the body is kept in equilibrium , then find the magnitude of the force which acts on the body in the direction of line of greatest slope of the plane downwards to make the body is about to move.

[b] ABCD is a square of side length 4 cm. The masses 6 , 4 , 3 and 2 gm. are attached at A , B , C and D respectively. Another mass of magnitude 10 gm. is attached at the midpoint of $\overline{AB}$ identify the distance between the center of gravity of the system and both $\overline{CD}$ and $\overline{CB}$

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3 **[a]** If $\overrightarrow{F_1} = 2\hat{i} + 3\hat{j}$, $\overrightarrow{F_2} = 4\hat{i} - 5\hat{j}$, $\overrightarrow{F_3} = -\hat{i} + 2\hat{j}$ acts at the points A (2 , 1) , B (– 1 , 3) , C (5 , – 7) respectively , find the sum of moments of these forces about the point of intersection of the medians of triangle ABC

[b] ABCD is square of side length 10 cm. forces of magnitudes 5 , 3 , 4 , 6 newton act at $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CD}$, $\overrightarrow{DA}$ respectively also two forces of magnitudes $\sqrt{2}$, $2\sqrt{2}$ newton act at $\overrightarrow{AC}$, $\overrightarrow{BD}$ respectively. Prove that the system is equivalent to a couple and find the magnitude of its moment.

---

4 **[a]** $\overline{AB}$ is a uniform ladder of weight 14 kg.wt. rests on a rough horizontal ground with its end A and a rough vertical wall with end B , the coefficient of friction between the ladder and the ground is $\frac{3}{7}$ and the coefficient of friction between the ladder and the wall is $\frac{1}{3}$. If the ladder is in equilibrium at a vertical plane perpendicular to the wall when it inclined at an angle of measure 45° to the horizontal , find the minimum horizontal force acts at the end A of the ladder to make it be about to move towards the wall.

[b] Two like forces of magnitudes 5 and 8 newtons act at the two points A and B where AB = 39 cm. If another force of magnitude F in the same direction is added to the first force , then the resultant will move 8 units. Find F

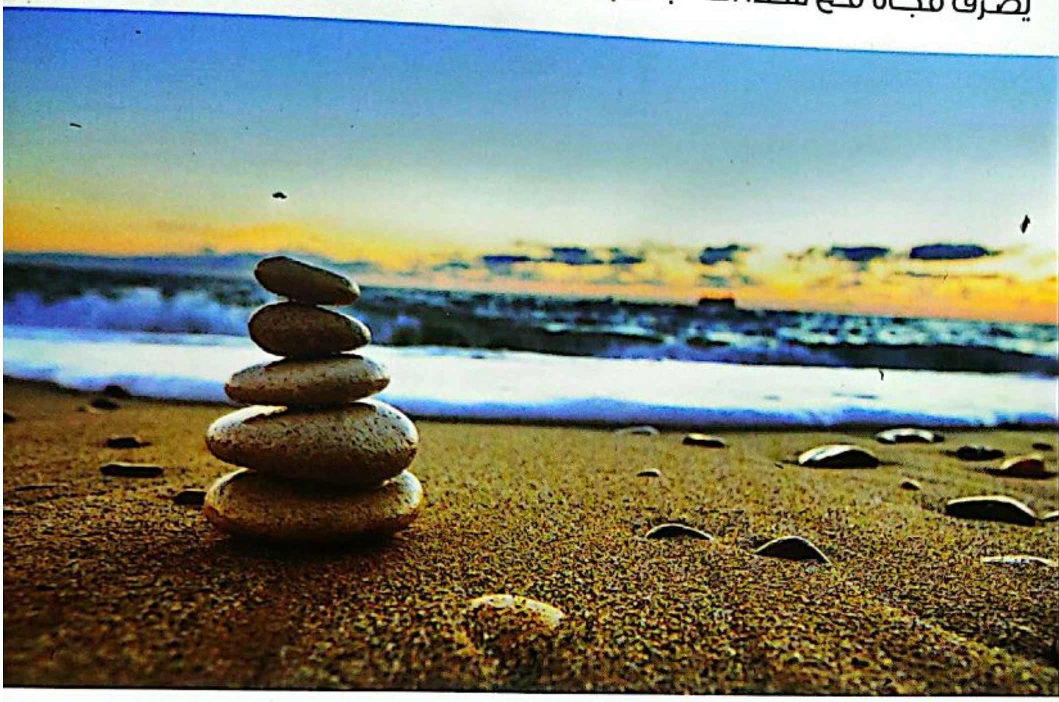
5 **[a]** A fine lamina of a uniform density in the form of a rectangle ABCD in which AB = 6 cm. , BC = 10 cm. and $E \in \overline{AD}$ such that AE = 6 cm. , if the triangle ABE is bent about the side $\overline{BE}$ until $\overline{AB}$ coincident with $\overline{BC}$ completely , find the position of the centre of gravity of the lamina after bending it with respect to $\overrightarrow{CB}$, $\overrightarrow{CD}$

[b] $\overline{AB}$ is a rod of length 90 cm. and weight 50 newton acting at its midpoint rests horizontally on two supports , one of them at end A and the other at a point C which distant 30 cm. from B carries a 20 newton weight at a point distant 15 cm. from B. Find the value of pressure exerted on each support , then determine the magnitude of the weight which should be suspended from end B such that the rod is about to rotate. What is the value of the pressure exerted on the support at C hence ?

Notes

Notes

يُصرف مجانًا مع هـذا الكتاب الجـزء الخـاص بالإجـابات



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